Alternative Methods for Assessing Income Convergence among European Regions in the period 1995 - 2007

Contents

Introduction

Economists have always perceived the importance of economic development and growth. Such attention is easily understandable considering the influence that growth has on human well-being. A lot of studies, both empirical and theoretical, have been published as attempts to explain disparities among countries: many theories flourished, none of which, though, provide an entirely convincing explanation and, in some cases, give rise to contrary policy recommendations.

In this field, lately, the debate has largely been focused on the controversial question of convergence, divergence or polarization among countries or regions with different levels of welfare. However, in spite of the number of works, empirical evidence does not offer any conclusive result in favour of one of the positions.

The question of economic convergence whether among countries or regions of the European Union has always had a special interest: the explanation can be found mainly in the raison d'être of the Union, since one of the basic principles on which it is based is integration and convergence is necessary to the purpose of attaining the highest possible level of economic and social cohesion, as stated in the new Union Treaty.

In the last ten years, then, there have been two big happenings which renew the interest at community level: a new currency has been adopted by many members and EU experienced the biggest enlargement of its history. Such events refresh the needing of testing at which stage European inequalities stand and if after them there were further significant improvements in convergence.

The existence of many methods of assessing it – developed during several decades of researches – and the absence so far of an analysis which applies them to the regions of new European Union, comprehensive of 27 countries, has been the fundamental arguments which made me think that there were space for a study as the following.

I.1 Brief History of Process of European Integration

The first ideas concerning a union among European countries dawned after the Second World War with the primary aim of guaranteeing them a long-lasting peace.

In 1951 European Cool and Steel Community (ECSC) began to join its six members (Belgium, France, Germany, Italy, Luxembourg and Netherlands) in economic and political field and in 1957 they merged into a more general European Economic Community (EEC) which had, among its goals, the creation of a single common market characterised by free movements of goods, services, workers and capitals.

The first enlargement occurred in 1973 with the entries of Denmark, Ireland and United Kingdom and in the following years there was the end of the last European right-wing dictatorships with the fall of Salazar in Portugal (1974) and the death of Franco in Spain (1975). In the same years community policy started to design structural funds for less developed regions, aimed to create job positions and build infrastructures and in 1979 the first universal suffrage elections for European Parliament took place.

In 1981 Greece became the tenth member of EEC, while Portugal and Spain joined the Community in 1986 when it was signed the Single European Act, which provided for solving the problems that still affected the free exchanges among countries and thus created the common market. In 1989 the fall of Berlin Wall was the beginning of the process of reunification of Germany which soon was united again. Just few months passed before the fall of all communist regimes, historical events which indeed had the result of making closer European people.

In 1993 the common market was completed, based on the four freedom mentioned before; in the same year in Maastricht it was signed the Treaty on European Union which turned the Economic Community indeed into a Union and led to the creation of the single European currency, the Euro. In 1995 Austria, Finland and Sweden joined the Union, in a framework where the Schengen Agreement had already created a European borderless area which today still operates much like a single state for international travels with border controls for travellers travelling in and out of the area, but with no internal border controls. It was then emblematic the development of

Erasmus Programme (European Region Action Scheme for the Mobility of University Students), which has been allowing to millions of young people to study in a foreign country.[1] In 1999 the Treaty of Amsterdam amended the Maastricht Treaty, putting a greater emphasis on citizenship and individual rights; two years later, in Nice, a new Treaty reformed the institutional structure of the European Union in the prevision of an eastward expansion.

1st of January 2002 was an historical date, since the new single currency started to circulate in 12 countries[2] which first adopted Euro. In 2004 with the entry of eight former communist countries (Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary and Slovenia) the divisions between Eastern and Western Europe, arose after Second World War, could be considered concluded; together with such countries, Mediterranean islands of Cyprus and Malta joined the Union too; then it was the turn of unratified "Treaty establishing a Constitution for Europe", an attempt to create a consolidated constitution for European Union which would have replaced the existing EU treaties with a single text. In 2007, while also Slovenia adopted the Euro – preceding Cyprus, Malta, Slovakia and Estonia – Bulgaria and Romania were the last to join the Union, although they have not been included in Schengen Area; Lisbon Treaty amended the previous treaties, which comprised the constitutional basis of EU, with the stated aim of completing "the process started by the Treaty of Amsterdam and by the Treaty of Nice with a view to enhancing the efficiency and democratic legitimacy of the Union and to improving the coherence of its action."

Today there are still many people who think that Europe should be endowed of a true constitution, however an agreement on this subject appears hard to achieve and the debate on the future of European Union is open more than ever before.

I.2 Database

The choice of records object of the analysis is a step of basic importance, since all the researches show that results are very susceptible to aggregations of data took in consideration, both under a geographical and economical point of view.

1 With obvious effects in terms of culture of integration for new generations.
2 Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Greece.

All the data, but two[3], come from Eurostat regional database and a description of their characteristics is provided in sections 3.3.1 and 5.3.1.

We will use monetary variables expressed in Purchasing Power Standard in order to reflect in a better way the standard of living of people from different regions[4].

Geographically, the aggregation considered is the Eurostat standard Nomenclature d'Unités Territoriales Statistiques (NUTS) at level 2. NUTS-2 should identify regions with population from 800,000 to 3 millions, but actually such thresholds are not used rigidly: regional context is very heterogeneous, we pass from 20,000 inhabitants of Åland (Finland) to a population of about 10 million, like those of Île de France or Lombardy; the same happens if we look at regional surface, since there are regions smaller than 1,000 km^2 (for example Brussels and Malta) and on the other side we register the extreme case of Övre Norrland (Sweden) with its 165,296 km^2. It appears logical that Eurostat should reorganize better these divisions and we could indeed use another aggregation to test convergence, nevertheless European Union chooses to act at this geographical level in order to promote cohesion[5] and it is mainly for this reason that we have chosen to use it: if there are any effect due to community policies, it should be registered at NUTS-2 level. A complete list of regions involved is provided in Annex.

Finally, time period from 1995 to 2007 is chosen in order to have a representative interval of years for capturing what was the situation before the important events mentioned before and their impact. We have used income statistics until the last regional observations available, those of 2007[6], to have the newest data for representing the present situation, even if it must be remembered that, after that year, the world experienced a big financial crisis, followed by another relevant economic crisis, which, to some extent, have changed the scenario. In any case, in this analysis we tried not to forget what has happened after 2007 and in some considerations this aspect will emerge clearly.

3 Democracy index and index of political situation.
4 PPS is used by the most growth scientists and we think that especially in a European framework these can be a very reliable values.
5 Structural funds are, in fact, basicly allocated in accordance with NUTS-2 division, even if many scientists suggest that the NUTS-1 level might be the only one pertinent especially in case of the smallest countries.
6 Regional database takes more time than national statistics to be prepared.

I.3 Highlights

Chapter 1 presents a summary of the neoclassical models of economic growth – both exogenous and endogenous – which will be used as theoretical basis for assessing convergence. After the introduction of the models there is a review of the results that can be found in literature through the use of alternative methods for assessing convergence.

Chapter 2 shows the results of a conventional[7] analysis focused on β coefficient carried out through the estimate of linear regression on panel data. Starting from this, there are then deeper examinations of the characteristics of convergence clubs and of some national peculiarity.

In chapter 3 it is used the method proposed by Quah (1993,1996b), involving Markovian systems, for executing a non-parametric analysis of the dynamics of evolution of income. On these bases we try then to inquire into the reasons that may have caused the relative mobility of European regions.

Chapter 4 separates regional convergence from economic growth and presents an analysis made with a traditional tool[8] (Theil Index) which allows to distinguish between inter-county disparity and intra-country inequality.

In Chapter 5 we come back to use the concept of β-Convergence through the Barro's approach and all it will be debated the quantitative effect of each variable influencing growth.

Before the Annex, where it is provided the list of the regions, it is presented a summary of the results obtained with and some final considerations.

7 As called by Cuadrado-Roura, Mancha-Navarro and Garrido-Yserte, 2002.
8 In the sense specified in Section 1.2.

1 Theories of Economic Development and Results

1.1 Theories

The purpose of this section is providing the key elements of the theories that empirically we are going to assess later and which have specific importance in a European regional framework.

We will consider neoclassical models which base their roots in the standard model formulated independently in 1956 by Solow and Swan. Neoclassical economists essentially maintain that regions with similar preferences which have access to the same technologies will converge toward the same steady-state level of per capita income, thus poorer regions will catch up the richest.

The standard formulation of the Solow-Swan model depicts how saving, population growth and technological progress influence an economy per capita output and its temporal evolution. It emerges that one of the most important variable for explaining economic growth is capital per worker, but it is generally accepted that human capital and changes in technologies play a role even more relevant.

Considering first a closed economy which has perfectly competitive markets and constant returns to scale, we can write the aggregate production function at time t as follows:

$$Y_t = F(K_t, L_t \times E_t) \qquad [1.1]$$

where Y is real production; K is total stock of capital; L is labour supply that is equal to total population since we assume full employment and E is a measure of labour efficiency. This variable is mainly affected by two dimensions: the knowledge of the workers and the disposable technology. E increases, for example, with computerization or automation, but also in correspondence of better health conditions, education or professional skills. Hence $L \times E$ represents the effective labour force or effective

worker.

Leaving out the subscript t, we can rewrite equation 1.1 as:

$$\psi = f(\kappa) \qquad [1.2]$$

where $\psi = Y/(L \times E)$ and $\kappa = K/(L \times E)$ that is, quantities per effective workers.

Omitting government, product per effective worker is allocated between consumption and investment: if we assume that agents save a fraction s of their income and thus consume a fraction $1-s$ we can write the following relation:

$$\psi = (1-s)\psi + i \qquad [1.3]$$

which brings us to the conclusion that saving rate correspond to the share of income that is formed by investments.

If we substitute equation [1.2] in equation [1.3], rearranging we find:

$$i = s \cdot f(\kappa) \qquad [1.4]$$

which relates the existing stock of capital per effective worker with the accumulation of new capital.

Assuming a rate of depreciation of capital of δ net investment is given by:

$$\dot{K} = sY - \delta K \qquad [1.5]$$

but if we want to find the evolution of capital per effective worker, we must take in consideration also the growth of population L – which is at a constant rate n – and labour efficiency growth. The simplest hypothesis about E is assuming an exogenous labour-augmenting technological progress at rate g. In conclusion the number of effective workers grows every period at the rate $(n+g)$, hence we can write the temporal evolution of capital per effective worker as:

$$\dot{\kappa} = s \cdot f(\kappa) - (n + g + \delta)\kappa \qquad [1.6]$$

On the households side, they are assumed to maximise lifetime utility given by:

$$U = \int u(c) e^{-\rho t} d t \qquad [1.7]$$

where c is per capita consumption C/L and ρ is a discount factor which reflects temporal preferences. For computational reasons we assume a utility function with form

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma} \qquad [1.8]$$

which has the advantage of having constant marginal utility $u'(c) = -\sigma$. Maximising [1.7] with respect to c subject to [1.8], we find the optimal time path for consumption per worker

$$\dot{c}/c = (f'(\kappa) - \delta - \rho)/\sigma \qquad [1.9]$$

that will converge asymptotically to the steady-state path for any initial level of K and L.

In the steady-state the quantities per effective worker ψ^*, κ^* and consumption are constant; per capita output y, per capita capital k and per capita consumption c experience a growth equal to the rate of technological progress g and the aggregate quantities of income, capital and consumption grow up at the constant rate $g + n$.

This model has clear implications in terms of convergence. We can specify equation [1.1] with a Cobb-Douglas production function:

$$Y_t = k_t^{\alpha} (L_t e^{gt})^{1-\alpha} \qquad [1.10]$$

which in per capita terms becomes:

$$y_t = \frac{(e^{gt} L_t)^{1-\alpha}}{L_t} K^{\alpha} = e^{gt(1-\alpha)} L_t^{-\alpha} K_t^{\alpha} = e^{gt(1-\alpha)} k_t^{\alpha} \quad [1.11]$$

Remembering the relation:

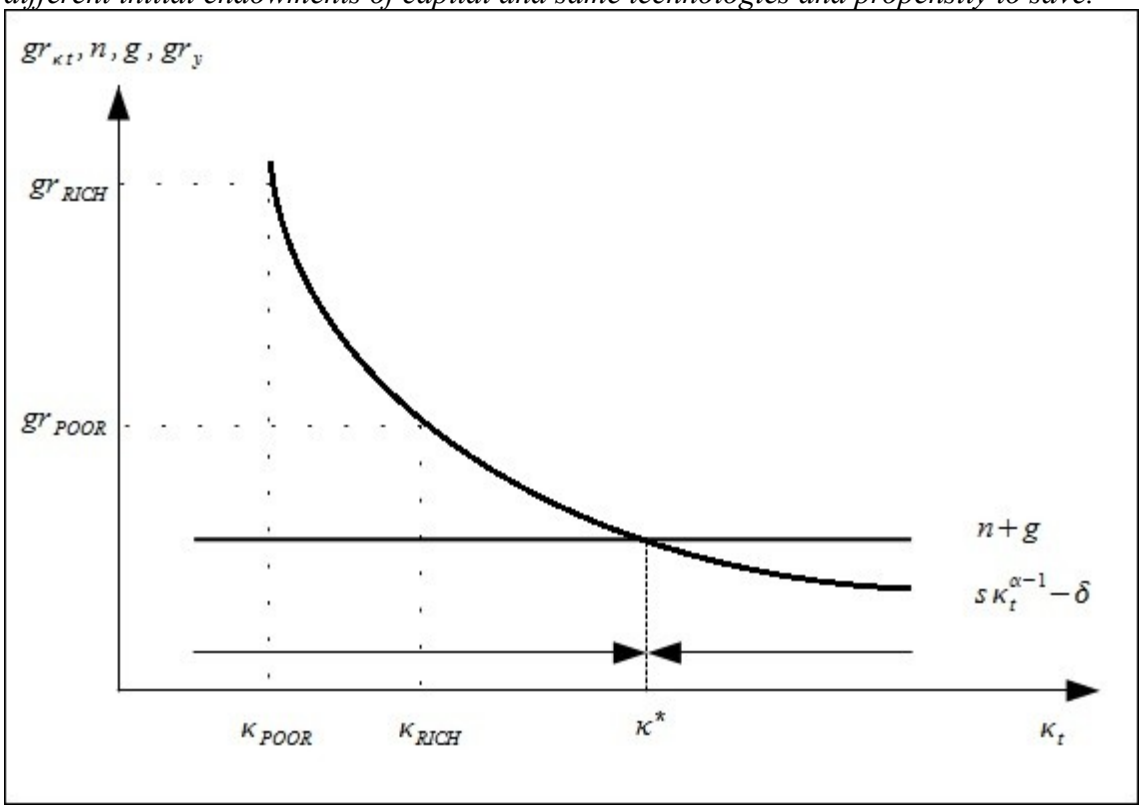
$$K_t / L_t = k_t = \kappa_t * e^{gt} \quad [1.12]$$

we can write equation [1.6] substituting $y = f(\kappa)$ and we have:

$$\frac{\dot{\kappa}}{\kappa_t} = s e^{gt(1-\alpha)} k_t^{\alpha-1} - (n+g+\delta) = s\kappa_t^{\alpha-1} - \delta - (n+g) \quad [1.13]$$

This last expression can be decomposed in net capital accumulation per effective worker

Figure 1.1 *Traditional neoclassical model of exogenous growth for two economies with different initial endowments of capital and same technologies and propensity to save.*



$s\kappa_t^{\alpha-1}-\delta$ and growth rate of population in terms of efficiency units $(n+g)$. The first term is a decreasing function of κ_t since $\alpha<1$ according to the hypothesis of diminishing marginal productivity of production factors, hence growth rate of capital per effective worker, as represented in figure 1.1, is high in correspondence of low levels of κ_t : with such levels of capital, its marginal productivity is high and it is consequently high its accumulation. Moving along the curve on the right, the accumulation slows down, since with more abundant capital, its productivity has decreased. The curve of net capital accumulation and the constant $(n+g)$ meet in correspondence of κ^* which, as we have seen, is the steady-state quantity that remains unchanged through time and which is reached automatically by economic systems that works as described.

We can easily see that in this model a less developed economy experiences a higher, but decreasing, growth rate until capital per effective worker will not reach κ^*, the constant rate growth path; whereas an area which is more endowed of capital grows at a lower and still decreasing rate, but converging again toward the same steady-state quantity.

If we do not consider technological progress, it is sufficient that output grows of n to avoid unemployment, but taking into account g it is necessary that production compensates it, otherwise it would be possible to employ less workers for the same level of output. In this sense g acts as the number of workers increases.

Suppose now that technological progress is like a manna from the sky, a free good, disposable for every country without difficulties or delays. In this way g would be the same everywhere. Hence:

- the growth rate of per capita income tends to such value;
- the growth rate of per capita income is higher when capital per worker is low;
- per capita income level tends everywhere to the steady-state path relative to $\kappa * e^{g\,t}$.

These statements are the foundations of the neoclassical theory of convergence which predicts absolute convergence, that is economies which are poorer in per capita income levels tend to grow faster than richer economies. Nevertheless, if we remove the

assumption about perfect mobility and reproducibility of technological progress or if we allow saving rates and growth rate of population to vary across countries, we may observe different steady-state growth rate of per capita income and different steady-state paths: this is the basic idea of conditional convergence, which is conditioned by the other variables of the model.

Solow-Swan model prescinds from monetary considerations. This can be a serious omission at worldwide level, but such considerations are less important at regional level, especially considering that 174 over 271 EU regions have today the same currency. However the openness of the system cannot be ignore neither at regional level, thus factor mobility and diffusion of technological changes become important issues.

In contrast to the neoclassical theories there are, among others, the ideas of Myrdal (1957) and Kaldor (1970), according to which a greater integration may allow the more developed areas to exploit more completely agglomeration economies through scale and density effects. The result of such effects is leading to further divergence. This topic is examined also by the so-called "new economic geography" since the beginning of 90s[9].

The better way of capturing the phenomenon of technological spillover is developing a model which explicitly considers human capital.

Romer (1986) relaunched the growth literature with a paper that presented a model of increasing returns in which there was a positive steady-state growth rate that resulted from endogenous accumulation of knowledge[10].

Technological change can be considered a labour augmenting process: suppose now that the effective labour input is equal to:

$$L \times E = LT \qquad [1.14]$$

where T is a measure of the average quality of labour, depending of skills like theoretical knowledges and practical experiences. It can be seen that Solow-Swan model

9 For a detailed discussion of neokeynesian regional growth theories see McCombie (1988b).
10 We present this model following notation used by Button-Pentecost (2002).

is a particular case for which growth rate of T equals to g.

The evolution of T follows the process of knowledge creation given by:

$$\dot{T} = H(R/L, T) \qquad [1.15]$$

where R represents the total expenditures on activities such us education, training and Research & Development originated both from public and private sector. Change in T is thereby positively related to current level of labour quality and to the effort for improving such level.

This effort can be measured by fraction m of annual output that is aimed to the process of technical change:

$$R_t = mY_t \qquad [1.16]$$

In this way, it arises a temporal trade-off, because m reduces current consumption, but allows a higher level of income in the future.

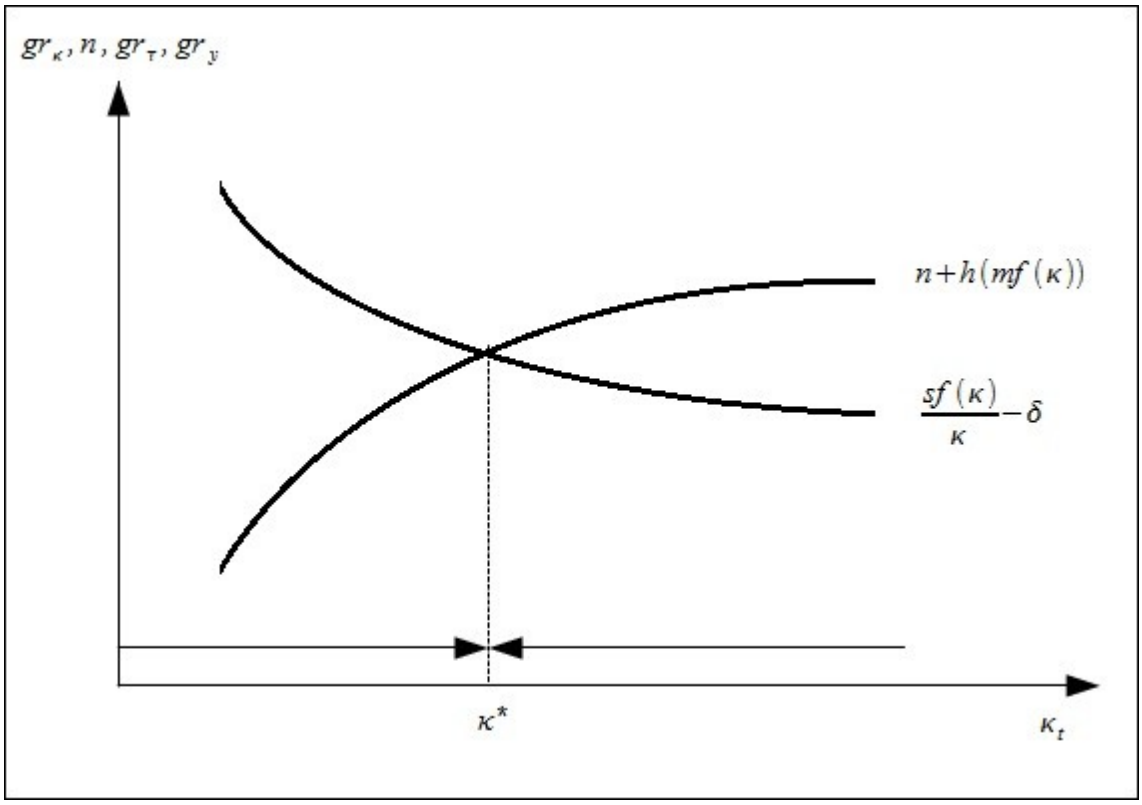
If production function is the same of equation [1.2], then substituting it and [1.16] in [1.15] and remembering that $\psi = Y/LT$ we can write the growth rate of T as follows:

$$\frac{\dot{T}}{T} = H\left(\frac{R}{LT}, 1\right) = h(m\psi) = h(m \cdot f(\kappa)) \qquad [1.17]$$

Households maximise again their lifetime utility as they did in function [1.5], even if now they must take decision about two variable: propensity to consumption and propensity to allocate resources to technical improvement. Hence the steady-state growth rate of per capita income, differently from the standard neoclassical model, is now function not only of κ, but of m too. Assuming that propensity to save affects the capital accumulation as in Solow-Swan model, labour input again grows at the exogenous rate n, on the steady-state growth path – where s and m are constant – the growth equation, similarly to [1.6] is:

$$\frac{\dot{\kappa}}{\kappa_t} = \frac{s \cdot f(\kappa_t)}{\kappa_t} - \delta - [n + h\,(m \cdot f(\kappa_t))] \qquad [1.18]$$

Figure 1.2 *Neoclassical model with endogenous human capital accumulation.*



From this equation and observing figure 1.2 we can establish that:

- if propensity to save raises, then growth rate of per capita income and κ^* increase;
- if capital depreciation rate raises, then growth rate of per capita income and κ^* decrease;
- if population growth rate increases, then aggregate output grows faster, but κ^* and per capita income decrease;
- if propensity to allocate resources to technical improvement increases, then κ^* decreases, but aggregate and per capita output raise.

The endogenous model we have just analysed still assumes the growth rate of population as exogenous.

Considering that differences in the natural growth rates of population among EU regions are not very significant we should focus in net migration which, in a framework where people may move freely across countries, plays a very important role in explaining the evolution of regional population and human capital.

In perfectly competitive markets, production factors are paid their marginal product, hence if capital per effective worker equal to κ we can obtain that real wage in every period is $e^{h(m\,f(\kappa))t}\,f(\kappa)-\kappa\,f'(\kappa)$ and while capital, according to the neoclassical model, flows to regions where its per capita amount is low, net migration will be from low income regions to rich regions. Actually, due to capital market imperfection and uncertainties, real risk-adjusted rate of return of capital investment differential are small (Mankiw 1995) and, similarly, human capital migrates from regions where it is scarce to areas where it is abundant (Lucas 1988), a kind of brain-drain effect.

We can express the change in population and thus labour supply, dividing natural growth and net migration:

$$\dot{L} = nL + M \qquad [1.19]$$

with M follows an evolution given by:

$$M = q(L\,L^{f})\,(w - w^{f}) \qquad [1.20]$$

where q measures the speed of response of labour factor, which is imperfectly mobile, to real wage differentials and f stands for foreign.

Inserting equations [1.19] and [1.20] in a model as [1.18] we find a new growth equation as the following:

$$\frac{\dot{\kappa}}{\kappa_t} = \frac{s \cdot f(\kappa_t)}{\kappa_t} - \delta - \{n + q[(e^{h(m\, f(\kappa))t}\ f(\kappa) - \kappa\ f'(\kappa)) - w^f]\ L^f + h\ (m \cdot f(\kappa_t))\} \qquad [1.21]$$

This model illustrates that:

- in poorer regions with a lower real wage, emigration raises the capital per effective worker and thus increases its real wage level;
- regions with higher income attract immigrants who have the effect of diminishing κ and then slowing down the real wage growth.

In conclusion, migration should be an equilibrating mechanism, but what this model does not take into account is the effect of immigrants on technological change: since they are persons already skilled, who take with them their human capital there could be gains from their movements (brain-drain effect) not captured by equation [1.21]. Empirical findings suggest that, in most cases, immigration in developed countries has raised their per capita GDP, that is positive impact in terms of technological change, new ideas, and investments has bigger size than simple depressing effect described by the model and therefore such factor reallocation can lead to divergence due to cumulative causations rather than reducing regional disparities.

1.2 Results

We can distinguish different streams in studies concerning regional convergence: first, the contribution provided by regional scientists, which it may be called traditional[11], whose main reference may be considered the book by Molle, van Holst and Smit (1980): an analysis carried out with one of these tools will be presented in Chapter 4, through the use of Theil Index; second, the contributions coming from macroeconomic field of economic growth, that might basicly be divided in β-Convergence parametric method – which was particularly developed in numerous analyses by Barro and Sala-i-Martin – that will be presented in Chapter 2 and 5; and the others, among which, it deserves particular attention non-parametric method proposed by Quah (1993,1996b)[12], whose ideas are the inspiration for the analysis presented in

11 Terrasi, 2002.

12 Quah offered ample and systematic critics to Barro's approach, contesting the significance of β coefficient and stating that the right way to analyse convergence is studying the dynamics of the entire

Table 1.1 *Previous researches about convergence in Europe*

Authors	Sample	Peculiarities	Results
Traditional studies			
Molle, van Holst and Smit (1980)	76 EU9 regions. 1950-1970.	Use of different indexes of disparity. Denmark, Ireland and UK had not joined EEC yet.	Generalised decrease in disparity especially in the first decade. The most of total regional inequality is due to between-country component.
Suarez-Villa and Cuadrado-Roura (1993); Dunford (1995)	EU12 regions. 1950-1990.		Convergence process stopped in the last 70s and a phase of divergence was experienced at the beginning of 80s.
β-Convergence studies			
Barro and Sala-i-Martin (1991)	73 regions from 7 EU countries. 1950-1985.	Conditioned for country-effect and economic structure.	Stable estimate of β with a value almost equal to 2%.
Armstrong (1995a, 1995b)	85 EU12 regions. 1950-1992.	Idem.	Different convergence phases, with β under 2%. Slow down of convergence in 70s and 80s. Not confirmed the existence of convergence clubs within EU regions.
Neven and Gouyette (1995)	140 EU12 NUTS-2. 1980-1989.	Use of spatial factors	Convergence in the first part of 80s, but not in the second. Spatially, Southern regions converged at 4.4% a year in the first sub-period while North stagnated and vice versa in the second sub-period
Other studies			
Fingleton, Lewney and Pinelli (1996)	169 EU12 NUTS-2. 1975-1993.	Research for the European Commission on the effect of Single Market Programme.	Faster convergence in the period after 1987. In the same years country-effect lose significance. 1993 distribution is less polarized than in 1975.
Cheshire and Carbonaro (1995, 1996)	118 Functional Urban Regions (FUR). 1979-1990.	Importance of regional delimitation. Explanatory variables for testing spatial factors.	Peripheral areas grew faster than the central ones, whereas the core areas had grown faster from 1960 to 1975.
Quah and Magrini (1999), Cheshire & Magrini (1999)	122 EU FUR 1978-1994.	Idem.	Emergence of a divergence process.

distribution.

Chapter 3. In this section we propose a non-exhaustive review of the most important empirical findings about the evolution of EU regional income disparities obtained with the different methods of research. They are shown in table 1.1.

In short, these studies show a clear process of convergence occurred among European regions at least since 1950 and up to 1970; during the 1970s it was registered a slow down in convergence, due also to the international economic framework; whereas the direction of the process in the 1980s is controversial, but all the way convergence does not seem fast. What happened after is shown in the next chapters.

2 β convergence: A "conventional" analysis of convergence

In this chapter we are going to use linear regressions on panel data to assess the existence of convergence – measured with the usual parameter β – both absolute and conditional through the setting of a fixed effects model. In section 1 there is a resume of the methodological framework, followed by empirical results and consequent observations shown in section 2. Section 3 explores which are the common characteristics of regions pertaining to the different groups of convergence, features that can explain reasons why such different clusters have been created. In section 4, EU countries are divided in those which show a relevant country-effect and those which show clue of polarization inside themselves and then it is presented an analysis of situation of the latter. Finally section 5 provides a brief conclusion.

2.1 General and Methodological Framework

We start the analysis of regional convergence setting the traditional model in order to observe and study the general trend highlighted during the period from 1995 to 2007. Convergence is also computed for two sub-periods (1995-2001 and 2001-2007) for assessing if there is any difference in the size of the process. Although this kind of approach hides a lot of important elements necessary to understand the complexity of the changes happened in EU even in a not long lag, this is the natural starting point: further and more detailed analysis will be provided afterwards.

We are going to test two well-known concepts of convergence in the literature about regional growth: absolute β-convergence and conditional β-convergence, referred to per capita GDP. The analysis is carried out using annual panel data over 264 EU NUTS-2 regions (data for the whole lag of time are not available for Denmark and for two regions of Scotland, in both cases due to changes in the borders).

The aim of studying β-convergence is to see if the heterogeneity of the

distribution of per capita GDP among regions tend to increase or decrease over time, in other words if regions which start in a lower income position tend to experience higher growth rates – as predicted in the neoclassical theory – that eventually allow the development of a catching up process that let the less wealthy countries to converge toward the level of the richest ones.

In formal terms absolute β-convergence is tested in accordance with the following linear model on panel data[13] with the variables expressed in logarithms:

$$\Delta y_{it} - \Delta \overline{y_t} = \beta \left(y_{it-1} - \overline{y_{t-1}} \right) + v_{it} \qquad [2.1]$$

The first term shows the difference between per capita GDP growth of the *i-th* region in period *t* with respect to the Union's average during the same period. Explanatory variable is the relative level of regional GDP per inhabitant of the previous period.

With the availability of panel data we may estimate the existence of conditional β-convergence using the following equation:

$$\Delta y_{it} - \Delta \overline{y_t} = \alpha_i + \beta \left(y_{it-1} - \overline{y_{t-1}} \right) + v_{it} \qquad [2.2]$$

The new parameters α_i , which are now included, allow us to test the existence of specific regional factors influencing the convergence of regions and pushing them toward their own steady state. This is possible through the use of regional dummy variables and implies the estimation of a panel fixed effects model. This model enables us to assess all the hypotheses that underlie the concept of convergence, both absolute and conditional. If β is lesser than 0 and $\alpha_i = \alpha, \forall i$ differences between rich and poor regions decrease and tend to cancel each other out, hence all of them will move toward the same stationary state. However if $\alpha_i \neq \alpha$ inter-regional disparities in per capita GDP stabilise themselves and each region will move toward its own steady state.

13 Model [2.1] and [2.2] are used by Cuadrado-Roura, Mancha-Navarro and Garrido-Yserte, 2002.

2.2 Empirical Results

The results of the estimations shown in table 2.1 push us to the following considerations:

1. In the whole period considered, the rate of absolute β-convergence is just 1,44%. Such a rate is even lower than the very common average β of around 2% found many times in the literature. This result means that the period to half convergence is 48 years, hence the data show a very slow process.

Table 2.1 *Estimation of β-Convergence in per Capita GDP (linear models.*

	1995-2007		**1995-2001**		**2001-2007**	
	Absolute	**Conditional** (Fixed Eff.)	**Absolute**	**Conditional** (Fixed Eff.)	**Absolute**	**Conditional** (Fixed Eff.)
β	-0.0144	-0.1182	-0.0029	-0.3812	-0.0276	-0.1916
t-value	-11.13	-11.83	-1.49	-18.98	-17.06	-11.52
t-prob	0.000	0.000	0.137	0.000	0.000	0.000
R^2	0.0377	0.2144	0.0014	0.3785	0.1553	0.5047
Num. Obs.	3168	3168	1584	1584	1584	1584
H[1]	48	6	239	2	25	4

[1] An interesting measure to take into account is the convergence time for a given convergence rate β. Considering equation [2.1] and [2.2] we can say that time t, where y_t is halfway between initial level y_0 and steady-state level y^*, satisfies the condition $e^{-\beta t} = 1/2$, hence we can get the number of years necessary to halve regional economic gap H by solving $\log(2)/\beta$.

2. The comparison of the two sub-periods, that can be graphically appraised in figure 2.1, suggests that convergence did not take place during the fist one, whereas the parameter is significant in the second one. This implies that disparities decreased mainly or only since 2002. No explanation can be given with this type of analysis, but 2002 is a very emblematic year, since the so far biggest step toward EU cohesion was carried out: the new European currency actually began to circulate in 165 over 264 regions; moreover just a year later

the most important enlargement in the history of the Union was approved and, in 2004, 10 eastern and ex-communist countries (41 NUTS-2 regions) joined EU: the better integration of these economies with Western Europe could have given a new and more intense impulse to convergence.

3. The fixed effects models are statistically more consistent[14] since the tests over the existence of regional effects suggest to reject the hypothesis that $\alpha_i = 0$ and provide different results: the values of β are much higher than the formers, and R^2 - statistics show a satisfactory goodness-of-fit even if adjusted. The period to half convergence is approximately 4 years and such process took place also between 1995 and 2001. This means that the conditional convergence exists and it is not slow, since per capita GDP tends to stabilise itself among regions in the middle term.

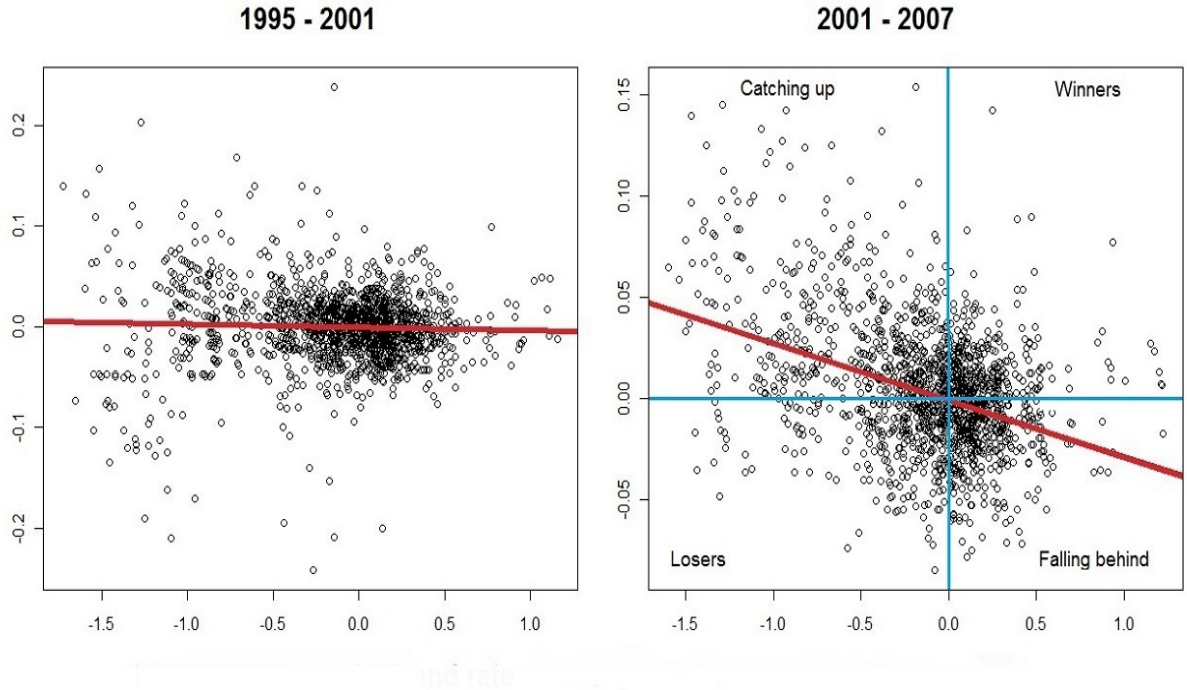
4. The existence of conditional convergence implies the estimation of different equilibrium states under the form α_i / β and, in general, shows that regions of EU have different behaviours. Considering only the magnitude of the fixed effects we can distinguish three kind of region:
   - those one with positive fixed effects, that is 62 regions having factors which positively contribute to their steady state;
   - 96 regions with negative fixed effects, which indicates the presence of factors slowing down their convergence;
   - a last group of 106 regions for which the estimated fixed effects are not statistically different from zero[15]. This means that for these areas no factors improving or slowing down convergence have been detected, hence we should find such regions around a line of absolute convergence, representing the average situation.

5. From regional fixed effects it can be noticed a clear pattern and regularities in

14 Analysis of residuals is quite satisfactory for all the regressions executed.
15 A t-prob of 0,10 has been used as limit to reject the null hypothesis.

terms of wealth or historical circumstances of the implicated areas. As a matter of fact, as shown in the map of figure 2.2, we can say that:

Figure 2.1 *Plot between log GDP and GDP growth rate with respect to EU average (per capita variables).*

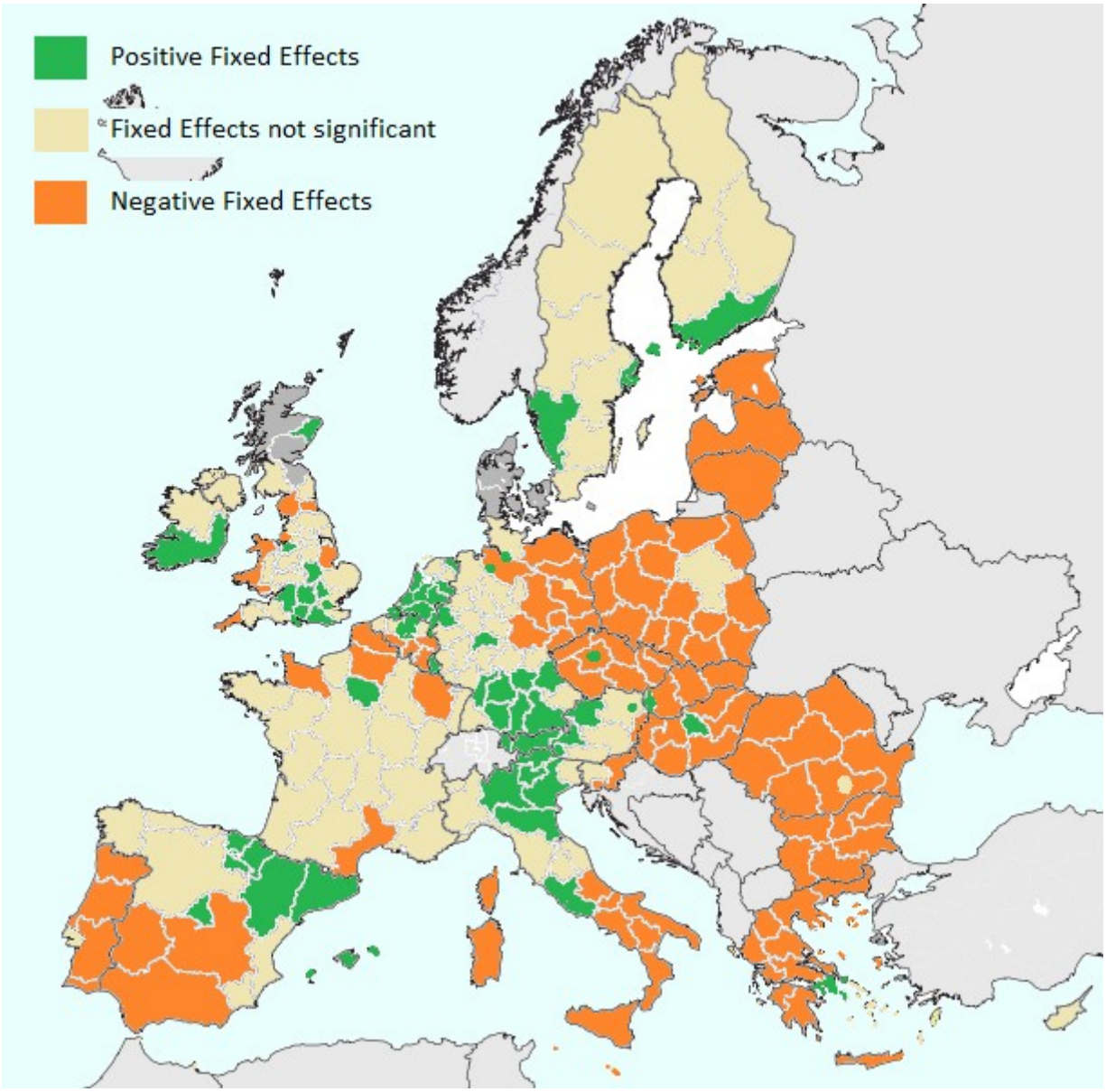


- positive effects emerge in the historically richest areas of Europe: along the axis between Southern Germany and the Po Valley; in the Lower Rhine; in Southern England, around London and in the Spanish regions closer to the rest of Europe. Positive effects are also present in areas corresponding to big metropolitan centres especially if they are country capitals: this often happens even in the poorer Eastern and Southern Europe;

- negative effects are present everywhere in Central and Eastern European Countries (CEECs) that joined the Union in 2004 and in 2007, including territories of the former German Democratic Republic; in the traditionally lagging regions by the Mediterranean Sea; in Portugal; in the marginal counties of United Kingdom; in the overseas territories and in some région in

the north of France as well as in Walloons, the french-speaking part of Belgium;

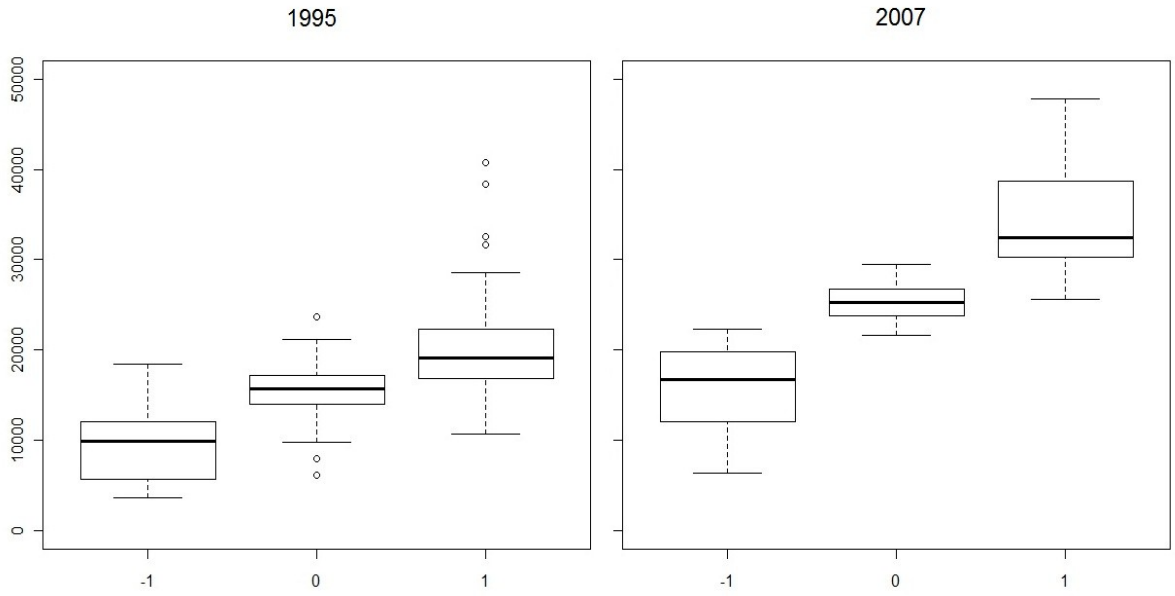
Figure 2.2 *Map of regional fixed effects.*



The extent of conditional convergence occurred between 1995 and 2007 can be detected through the observation of the compared boxplots of log per capita GDP of three different kinds of regions measured in initial and final year shown in figure 2.3. The easiest way to notice it is observing that, after 12 years, the three distributions

seem a bit more concentrated and that their overlap is more limited. This is a clue of within-cluster convergence. Nevertheless it is remarkable that the downward whisker of the regions with negative fixed effects in 2007 is longer, as well as the upper box of the ones with positive effects. This means that, even in a framework of conditional convergence, is emerging an asymmetry of the distributions toward extreme values.

Figure 2.3 *Boxplots comparison of log per capita GDP.*



Borders of plots represents lower quartile, median and upper quartile; dots are outliers.

2.3 Factors Related to Fixed Effects

After the determination of the signs of the fixed effects for every region we are able to look at which factors they are related with and which form has the relation: these factors can then be the ones that influence growth and push each region toward its steady state.

Let us consider a causal chain according to which $y \simeq fe_i \rightarrow \sum_k var_i \rightarrow \dot{y}_i$ where fe is the fixed effect of the *i-th* region, the arrows mean causality, var is a group of k variables which influence the regional growth $\dot{y}_i$. Assuming a functional form as:

$$var_{ik} = f(fe_i) \qquad [2.3]$$

in table 2.2 there is a resume of the results of some important demographic variables, together with variables referring to human and physical capital. Specifically, table shows the signs of first and second derivatives (if significantly different from zero), the average values for the three clubs of convergence and the F-statistic for assessing if there are significant differences in means depending on the group.

Table 2.2 *Relations between fixed effects groups and characterising variables*

Variables	$\frac{\partial var}{\partial fe}$	$\frac{\partial^2 var}{\partial fe^2}$	**F test**	**Negative fixed effects** (96)	**Close to 0 fixed effects** (106)	**Positive fixed effects** (62)
Demographic density	+	+	8.05	145	407	697
Rate of net migration	+	–	12.65	1.53	3.93	5.15
Life expectancy	+	–	47.15	75.2	78.2	78.4
% of university students	+	X	3.31	13.9	13.9	16.3
% of workers in technological sectors	+	+	76.80	24.2	31.4	37.1
% of expenditure in R&D	+	X	42.70	0.85	1.72	1.93
Per capita gross fixed capital formation	+	+	134.40	2322	4194	5608
Rate of unemployment	–	X	65.60	12.5	7.3	5.5
Infrastructure per km^2	+	X	37.60	10.9	25.5	37.0

[1] Symbols in columns of derivatives show which are the shapes of the fitted relations among the variables and the absolute size of the fixed effects (fe). + means derivative > 0, – means derivative < 0 and X means that quadratic relation is excluded.

[2] F test shows the value of F-Snedecor statistics which measure average differences of the three groups through an ANOVA analysis. Critical value for $F_{2,261}$, α=0,05 is 3,03.

[3] Last three columns show the average values for each group with different magnitude of fixed effects.

We see that more urbanized areas are bound to converge to a higher level of per capita GDP, as well as the richest regions attract more workers coming from other areas

and are the ones which have better health conditions, measured through proxy of life expectancy; level of income is positively related with expenditures in research and development and fixed capital formation, which, according to the theory, are variables that should have a great impact on growth; very significant is also the size and the direction of the relation with the percentage of workers in technological sectors – which are the sectors with higher value added and stronger propensity to innovation – and the inverse relation with the rate of unemployment that is an important cause of waste of human capital. With respect to propensity to study, we can observe that in richer regions propensity to study is higher for tertiary education but there are no effects on the percentage of people 15 to 24 years old attending upper secondary education: such result could appear paradoxical, since more financial resources should push young people to continue their education beyond what is compulsory, however it must be considered that when a region has higher level of income, young people tends more to abandon secondary school in order to take advantage of the circumstances, entering sooner in labour market. Although such choice guarantees immediate gains, this does not seem a good strategy in the long term, since unskilled workers are the weakest class in case of a slow down of the economy. Finally, richer regions are more endowed of infrastructures, which seem to be a precondition, also if not necessary, for growth.

Productive structure of the three groups does not differ in the size of the industrial sector, whereas differences are relevant in agriculture, where the poorest regions have employed a higher percentage of workers, often in activities with very low value added, and the richest ones have employment at the minimum physiological level. Different structure is present also in services, which are more developed in regions with positive fixed effects, especially if we consider trade and financial services.

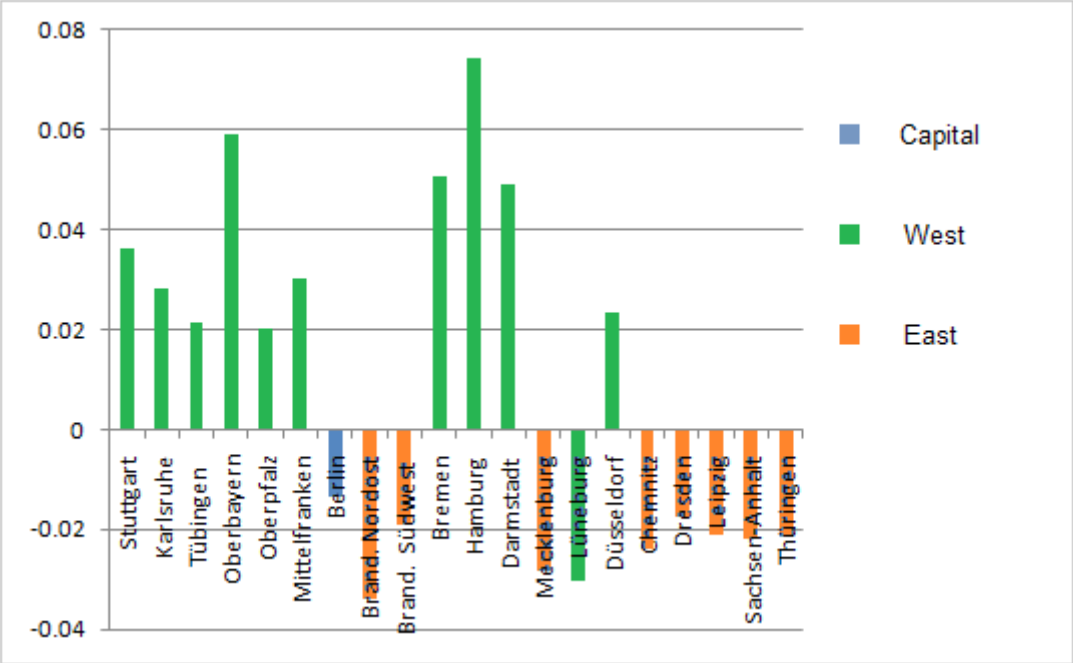
2.4 Country-Effects and Within-Country Disparities of Fixed Effects

Next step of the analysis is distinguish between those states which show a uniform pattern, that is where the country-effect is very strong and influences in only one way the performance of every region, and the other nations which show, for various reasons, dual economies:

- the country-effect predominates negatively in all the former communist places as well as in Greece and Portugal, whereas the only state with positive country-effect is Netherlands;
- we can detect five countries where different regions seem to converge toward various steady state (the steady-state club toward which they converge, as said, depends on the magnitude of the regional fixed effect which is represented by the height of the bars in the histograms. Different colours indicate different geographical or historical groups of regions inside the countries):

I. this is the case of Germany whose unification has not completely solved the question of integration between East and West which had opposite destiny during more than 40 years. East is affected by high rate of unemployment and strong emigration (negative balance of net migration), whereas there are no differences in propensity to study and these are not relevant in the productive structure, even if sectors are different qualitatively speaking;

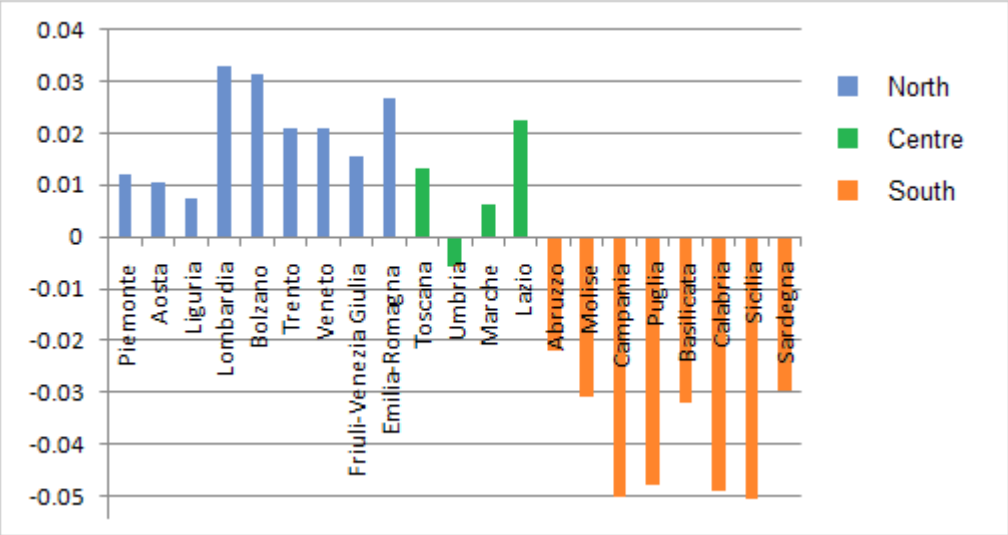
Figure 2.4 *Histogram of fixed effects in some representative German Länder.*



II. Italy, whose fixed effects are represented in figure 2.5 – the most classical

example of double or maybe triple development's speed – is a much graver case than Germany, since such problems have very deep historical roots and they are still unsolved after 150 years since its unification. Here the sign of the fixed effects is not related with demographic density: Italy is not experiencing a process of urbanization, but just the opposite, since during the last 30 years population of the bigger municipalities has been diminishing relevantly, whereas the process of abandoning the countryside has arrived to an halt: Italy is indeed a positive example of satisfactory quality of life even in rural areas. Looking at the other variables we remark that differences emerge especially among regions with negative fixed effects (the "Mezzogiorno") and the rest: the peculiarity with respect to EU average is the distribution of expenditures in R&D, on the whole very low, which is higher in regions with fixed effects close to 0 and not so different between the richest and the poorest regions. In the end productive structure registers in the Mezzogiorno more workers in agriculture and in public sectors and less in industry;

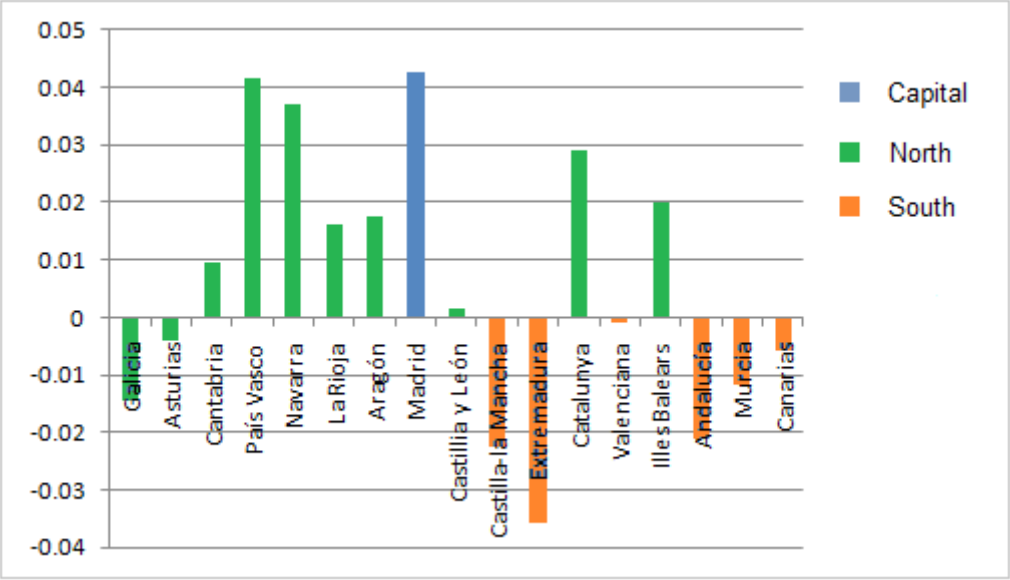
Figure 2.5 *Histogram of fixed effects of all Italian Regioni.*



III. the same geographical situation as Italy, but with a less strong polarization can be found in Spain, where the old industrial northern regions keep on having an advantage especially over the Centre and the South. The patterns are not odd,

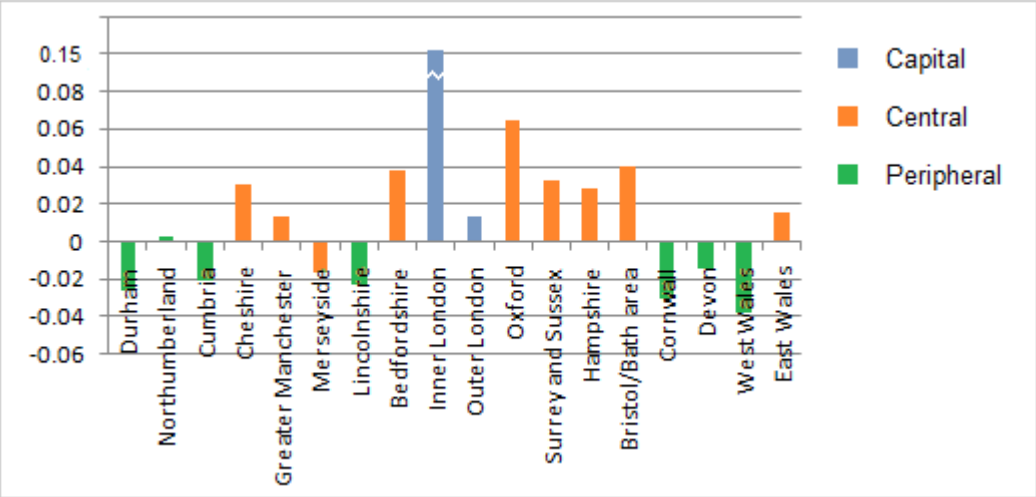
but it can be detected very low values in propensity to study, in human resources in science and technology and in expenditures in R&D. Spain has also experienced a strong immigration with the same magnitude everywhere and the same intensity of growth in all the comunidades, regardless of the initial level of GDP. Spanish regional results in term of fixed effects are shown in figure 2.6;

Figure 2.6 *Histogram of fixed effects of all Spanish Comunidades.*



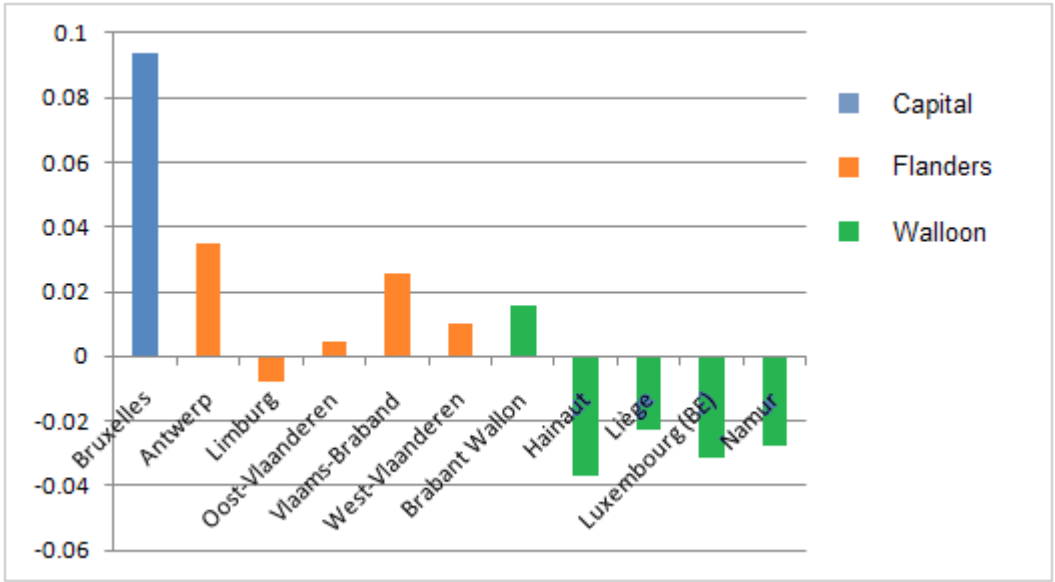
IV. United Kingdom shows instead a visible centre-peripheral dualism. Some missing values does not allows us to provide reliable descriptive statistics about education and migration. R&D and fixed capital formation are consistent with EU averages of the different kind of regions, except that, in UK, differences are stronger between regions with positive fixed effect and the rest. Productive structure differs mainly just in the size of financial sector, much higher in richer counties. The special feature of this country is that there are no significant differences among regions in term of productivity and unemployment and that even if we exclude the outliers values of Inner London, we find clues of divergence which we did not find in countries previously analysed. The extent of the fixed effects registered in some representative British regions is shown in figure 2.7;

Figure 2.7 *Histogram of fixed effects in some representative British NUTS2 regions.*



V. at last it is worth noting that in Belgium, whose situation is shown in figure 2.8, the different areas correspond with the linguistic regions of Walloon and Flanders with the former, the poorest, sensibly converging toward the same level than the bordering French zones and the latter approaching itself to Dutch regions. This can be an emblematic element especially considering that here the secessionistic pressures perhaps have not ever been as strong as now.

Figure 2.8 *Histogram of fixed effects of all Belgian provinces.*



2.5 Conclusions

In short, a weak process of absolute convergence took place among European regions in the interval between 1995 and 2007. Up to 2001 non-conditional convergence is nearly non-existent, while in the second 6 years the catching-up process is more intense. Models testing for conditional β-convergence fit better, suggest a quite fast approach toward the steady state of every region and reveal the existence of very various fixed effects. These effects are in many cases due to country factors, but there are remarkable exceptions, especially when the size of the state is bigger. What is clear is that, behind this pattern, a lot of regional peculiarities are hidden. Hence, it appears necessary to deepen the study of the different behaviours of EU regions beyond the conventional analysis.

3 Markovian Processes and Evolution of EU Regional Income Levels

In the previous chapter we saw that European regions act in a very different way and this implies that their evolution, in terms of economic growth, differs remarkably: while there are areas which have grown very little, worsening their relative position, others have performed surprising well.

In this chapter we will analyse the mobility of European regions through income classes using a Markovian system[16]. In section 1 we start the analysis by comparing what have been the distributions of per capita income at the beginning and at the end of the period, then we introduce Markovian systems and apply them to such variable. Once we have caught which are the dynamics, we are able to divide NUTS-2 in winners, losers and stable regions, according to the relative growth experienced and after some geographical considerations in section 2, we propose in section 3 a review of what could have been the explanatory factors of the economic growth measured with this method. Conclusions follows in section 4.

3.1 Income Distribution and Its Evolution through Time

Looking at the histograms of the frequencies in the various income classes (EU average = 100) represented in figure 3.1, we can appraise what steps toward European integration after mid-90s have meant for the improvement of EU cohesion in terms of wealth: even with this simple tool we may point out the trend clearly: the second distribution has values around its average with higher frequencies and the left peak has almost disappeared.

However, what this diagram hides is the contradictory dynamism that EU NUTS-2 have experienced in those years. They are not trapped in a fixed or stable

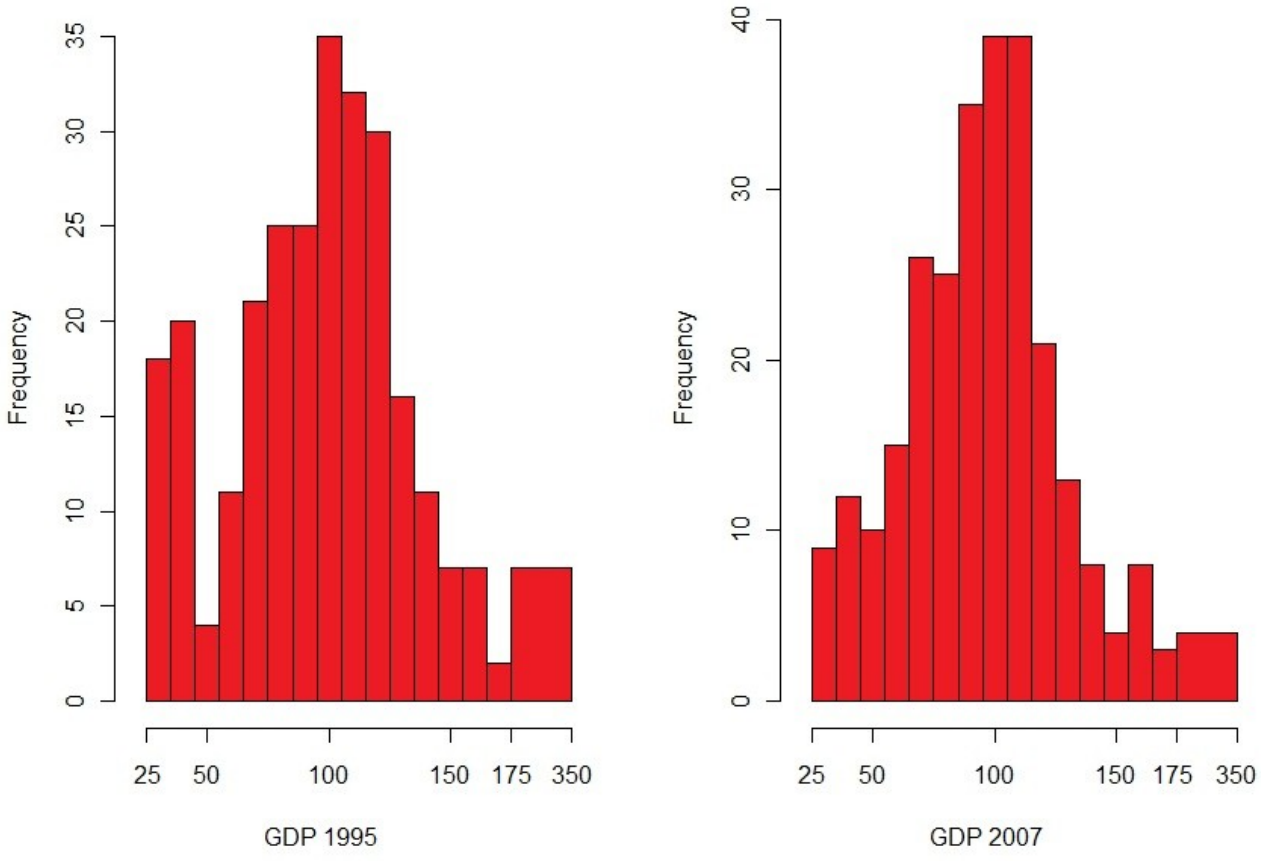
16 A Markov chain is the characterization of a system that transits from one state to another, in a chainlike manner, with the basic property that the next state depends only on the current state and not on the past.

position within an European ranking: on the contrary, remarkable shifts have taken place. With regard to this, it must be said that upward and downward shifts are recorded in any kind of region, since both richer and poorer regions have performed positively or have shown negative dynamics.

Markovian approach, mainly implemented by Quah, allows us to grasp satisfactorily the extent and the direction of the regional dynamics, enabling to split regions up in groups of winners or losers. Such partition is then the starting point for a further analysis tending to determine which factors are commonly characterising regional performances.

Given the assumption that regional income levels follow a stochastic process, seven different classes of per capita GDP with respect to EU average (=100) are

Figure 3.1 *Histograms of per capita income distributions (1995 and 2007).*



defined: < 50, 50-75, 75-90, 90-110, 110-125, 125-150 and >150[17]. Then we calculate the vectors of probabilities at the beginning (P_t) and at the end (P_{t+n}) of the period of *n* years. Third, transition matrices *M*[18] are filled tabulating which regions remain in the same class and which ones shift from one state to another in the initial and final year of the period. From an initial situation at time *t*, represented by the first vector, the probabilities of belonging to each class of income at time *t*+*n* can be obtained by solving the following equation:

$$P_{t+n} = M^n * P_t \qquad [3.1]$$

The equilibrium or ergodic solution is calculate when $n \to \infty$ so that we are able to obtain a vector *P**, which indicates the probability of resting at each level of income in the long term, independently from the initial situation. Obviously if central values of P* (corresponding to the classes around the average) are the highest, we are witnessing a process of convergence; on the contrary, if two or more peaks emerge, this means that we are observing a process of polarization.

Distributions of table 3.1 can be read as follows:

1. During the years 1995-2001 the final vector has higher frequencies than the initial one in the three central classes and smaller probabilities for the external states. Taking the ergodic distribution, we can see a peak in the central class, where we find the modal value (1/3 of the regions) and the distribution also has a shape which looks like normal. Kurtosis is 2.91, however its mass is a bit more concentrated in the lowest levels so we are in front of a right-skewed distribution.

17 This partition is considered adequate to perceive in the best possible way the changes. Considering Objective 1 areas (less than 75% of EU average) just in a class would not permit to note the evolution of many CEEC's regions. Obviously with any other arbitrary partition results would be different.

18 Transition matrix must fulfil the condition of homogeneity, irreducibility, recurrence and lack of periodicity in order to obtain results that are stationary, hence allowing a long term equilibrium solution (Artis et al. 1995).

2. Considering data of the second period, the modifications between initial and final frequencies are more controversial: in 2007 the probability to be in the 50-75 class is bigger than in 2001 whereas the probability to fall in the central interval from 90 to 110 has decreased. The result, for these years, is that regions have limiting probabilities which are almost uniformly distributed among the three classes going from 50% of EU average to 110%; modal value, here, falls in the class 75-90; the distribution is more skewed to the right than the previous one and it has no more normal-like shape. In this interval there is also the case of Guyane (overseas territory of France) that goes down in the lowest class, circumstance not happened before.

3. Looking at the distributions of the whole period we see that, after 12 years, frequencies have increased in all the classes from 50% to 125% of the EU average. These lead to an ergodic distribution which presents 1/4 of the regions with an income level lesser than 75%; almost uniform values (0.2855) in the classes 75-90 and 90-110 (but density is higher in the former, since the range is smaller) and just 1/6 of the regions with a per capita GDP bigger than 110.

Hence the results obtained show a very poor convergence, but the situation is not so clear and some considerations need to be made:

1. The process of convergence is very slow considering that the number of necessary steps to obtain the limiting probabilities is 30 and even if after 10 steps the distributions are similar, reaching a very low degree of convergence would still take 60 years. Moreover, convergence is particularly worse during the second lag of years: this is a result which extremely contrasts with what has been found through regressions made using the traditional model. Hence, what has taken place, according to Markovian analysis, is a slowing down process of convergence: this seems due to the stronger persistence in the same classes experienced in the second sub-period by the regions above the EU average, while mobility actually increased only for the poorest regions (<50).

Table 3.1 *Transition dynamics.*

Period 1			**1995-2001**				
	< 50	**50-75**	**75-90**	**90-110**	**110-125**	**125-150**	**> 150**
< 50	0.949	0.051					
50-75		0.800	0.171	0.029			
75-90		0.105	0.737	0.158			
90-110			0.131	0.672	0.197		
110-125				0.364	0.477	0.159	
125-150				0.088	0.353	0.441	0.118
> 150						0.250	0.750
Initial distr.	0.144	0.129	0.140	0.225	0.162	0.125	0.074
Final distr.	0.137	0.125	0.155	0.247	0.166	0.100	0.070
Ergodic distribution	0.000	0.137	0.260	0.343	0.170	0.061	0.029

Period 2			**2001-2007**				
	< 50	**50-75**	**75-90**	**90-110**	**110-125**	**125-150**	**> 150**
< 50	0.757	0.243					
50-75	0.029	0.824	0.118	0.029			
75-90		0.143	0.714	0.143			
90-110			0.194	0.716	0.090		
110-125				0.244	0.644	0.089	0.022
125-150					0.370	0.556	0.074
> 150						0.158	0.842
Initial distr.	0.137	0.125	0.155	0.247	0.166	0.100	0.070
Final distr.	0.107	0.159	0.173	0.244	0.166	0.081	0.070
Ergodic distribution	0.034	0.279	0.287	0.254	0.093	0.028	0.026

Whole interval			**1995-2007**				
	< 50	**50-75**	**75-90**	**90-110**	**110-125**	**125-150**	**> 150**
< 50	0.718	0.256		0.026			
50-75	0.029	0.771	0.114	0.086			
75-90		0.158	0.579	0.263			
90-110			0.328	0.508	0.115	0.033	0.016
110-125				0.386	0.455	0.136	0.023
125-150			0.029	0.118	0.500	0.235	0.118
> 150					0.050	0.300	0.650
Initial distr.	0.144	0.129	0.140	0.225	0.162	0.125	0.074
Final distr.	0.107	0.159	0.173	0.244	0.166	0.081	0.070
Ergodic distribution	0.023	0.233	0.286	0.285	0.104	0.045	0.035

2. Mobility is more frequent among regions with levels of income above average than among those ones with lower per capita GDP. Such detail can be noted looking at the values along the main diagonal of the transition matrices, which show the rates of persistence. In particular, only 23.5% of the regions that in 1995 were in the range 125-150 still stayed in the same level 12 years later: more than 60% of them had fall down in lower classes. The opposite happened in the specular class, ranging from 50 to 75: during the same years 77.1% of the regions remained in the that interval and just 20% of them changed to upper levels.

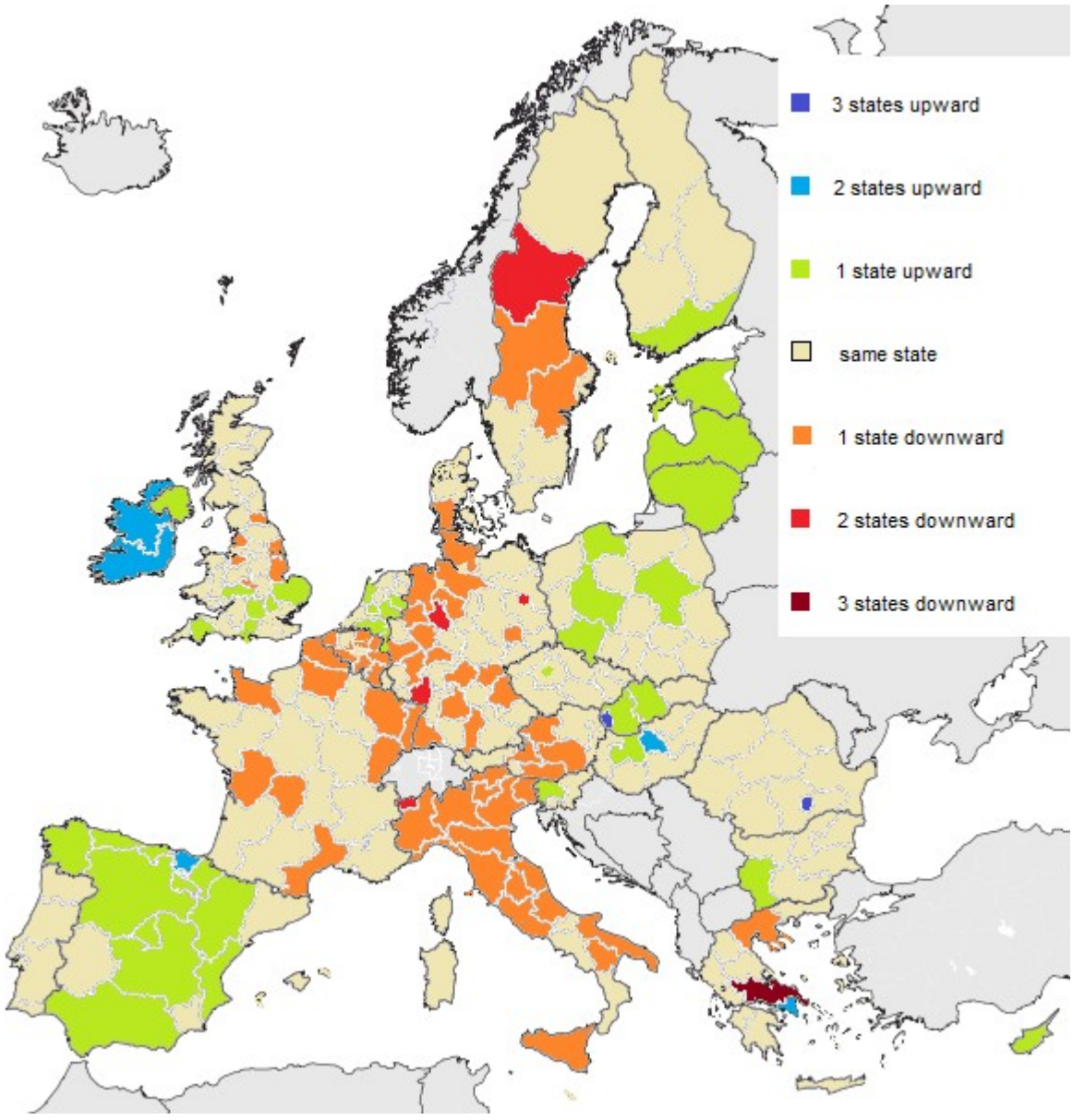
3. Even if lagging regions have generally experienced improvement, at the end of the period 67 of them have remained below the 75% threshold of EU income average. Nevertheless, only 16 of these regions have had an economic growth lesser than European average. It is the case of Northern Bulgaria, eastern regions of Czech Republic, some Greek and Hungarian rural areas and Calabria and Norte (Portugal) in Western Europe. These are really the most losers among the lagging regions and such situations should arise worries about the deep structural nature of their underdevelopment.

4. 122 regions experienced mobility and 149 had stability, hence the overall rate of persistence is 0.55, which is high enough to say that, even if the mobility phenomenon is relevant, there were not revolutionary changes in the regional ranking, considered also that only 4.8% of the regions moved to a non-contiguous state. Moreover, as introduced before, the degree of mobility is higher in the first period (0.32 versus 0.28).

3.2 Geographical patterns of economic growth

After having read and statistically interpreted the tables showing the main results of Markov chains applied to dynamics of European regions, it is very important to consider the outcome under a geographical point of view: spatial distribution and

Figure 3.2 *Map of winning and losing regions.*



direction of mobility can be seen in figure 3.2.

What appears immediately are the dominant country effects: in fact there are only two nations which have regions showing movement in both directions: United Kingdom and Greece. Besides it is worth to remark that:

1. All the CEECs have all their regions with non-negative movements and at least

an area which has experienced upward shift. In these countries the better performances have been carried out by the territories of the capitals, with Bratislava, Bucharest and Budapest protagonists even of double/triple jumps.

2. Although the relative situation in East Germany is better than in the territories of West, it has not followed the positive performances of the other former communist countries and the movement of the capital, Berlin, stands out negatively. The former German Democratic Republic did a different path than the other eastern nations: here there was the influence of what Boldrin and Canova[19] call *the Big Brother Effect*, that is the protection of the big Western Germany which tried to help the East during its transition through income support policies and abundant subsidies to firms. Besides, since its regions joined the European Community almost 15 years before than CEECs, they could also take advantage of the Community Structural Fund. Growth was rapid during the first years after unification, but it slowed down already in the second half of 90s and the overall performance was quite mediocre. Remembering that, anyway, East Germany is nowadays much richer than the other former communist countries, we might say that these latter are experiencing now the boost due to integration which it saw before, but, for the above-mentioned authors, differences are not only temporal, but especially in terms of quality of investment (mainly in construction for former GDR whereas they have been directed to the most productive sectors at least in the most successful countries, like Hungary, Slovenia, Poland and Slovakia).

3. The core of the Old Europe – the six founders plus Austria – shows everywhere non-positive movements, with the only exception of Netherlands (it was already one of the richest country and in 2007 it was ranked third). This is consistent with the relative decline of many old industrialised areas, like Rhine Valley and it makes positive performances of Southeastern England even more remarkable. Movements to a lower state are especially intense and extended in Italy,

19 Regional policies and EU enlargement, 2002.

involving 84% of its population: the missing growth is particularly grave considering the size of debt of this country. Its relative impoverishment had a strong acceleration since 2001 and such situation makes Italy the big sick of Europe.

4. In Western Europe positive trend are registered in Ireland and in the most Spanish comunidades. These two countries are two emblematic and very different examples of growth: there are differences in the size of their population (4 millions versus 45 millions); in temporal evolution of their income; but also in the way they have promoted their development. This is an elements which we will have something to say later about.

3.3 Explanatory Factors of Per Capita GDP Growth

In this section we try to investigate which characteristics have been relevant for EU regions growth, that is finding some common elements for each group of winning, stationary or losing regions – which differentiate it from the other groups – in order to discover some explanatory factors of regional mobility observed.

3.3.1 Description of Variables

To explore these possible factors we have chosen some variables which a priori should have some influence on per capita GDP evolution of NUTS-2. The variable selected are described in the following sections[20].

3.3.1.1 Population

- *fertility* is used to capture one of the dynamics of natural growth of population and to some extent it is expected to be negatively related to movement across classes of income.
- *demographic density* is used as a proxy for urbanization level and it should be higher for the winners since we have seen the tendency toward concentration of economic activities in metropolitan areas.

20 Sometimes proxies are used because of the lack of more adequate series.

- *migration* is a way to measure the attractiveness of an area for the human factor: labour mobility is analogous to capital mobility and it differs from natural changes in population because it has repercussions both on source and destination territory and because immigrants, unlike newborns, are persons which are already endowed with some skill. Net migration is certainly higher for the richest regions since it should basically depends on the expected wage, but behaviour should not follow a clear pattern if we consider mobility across levels of income as discriminant and if we remember that it has also a negative effect on per capita GDP through swelling of population.
- *life expectancy*, which is a variable representative of the health conditions of the regions, should be higher for richer slowing down regions. Furthermore it proxies for features that reflect desirable performance of a society, as better work habits.

3.3.1.2 Production

- inserting *initial and final per capita GDP* has the purpose of assessing which are the income conditions for each group: it is expected to find a bigger value for losers and smaller for winners, according to the findings about convergence, but we do not have any a priori ideas about the final distribution.
- *GDP* total *growth rates* and of every sub-period have been chosen to capture differences in regional trends. These variables will result obviously related with the classes, hence the true aim of inserting them in the analysis is seeing what are the sizes of these differences among groups and checking if they have the same significant magnitudes in each sub-period.
- *Gross value added growth* measures evolution in productivity which should be related directly with regional performances.

3.3.1.3 Human Capital, R&D and Fixed Capital

- three human capital indicators, in terms of education, have been taken: they show population percentages (25-64 years old) by educational level: *lower secondary, upper secondary and tertiary education attainment*.

- percentage of *human resources employed in scientific and technological sectors*; percentage of *expenditures in research and development*[21] to measure the regional effort for innovation and higher productivity.
- *gross fixed capital formation* (per capita) has its own worthiness to show the pattern of economic growth and especially the degree confidence of investors, since they will choose investment in fixed assets only if forecasts are good for long-term[22]. Besides it is also a proxy for investment and, since it is per capita, it should have some connection with the disposable capital per worker too.

The growth of all these variables, according to theory, should have a positive influence over the income level of a territory.

3.3.1.4 Production Structure

- The allocation of workers in sectors as their growth rate have crucial importance on the evolution of productivity, and hence of economic performances. In the analysis we have used both *initial and final size of the sectors* and *their growth* during the years from 1995 to 2007. We have not taken in consideration traditional three-sectorial partition, but a distinction among *agriculture, industry, construction, trade, finance and real estate and public sector.* This because we think that such partition allows a better interpretation of the phenomenon of growth in the various EU regions. Moreover, depending on which sector growth is based on, it might be more or less weak, more or less lasting.
- *Employment growth* is used as control variables.

3.3.2 Empirical Results

The method used is a statistical contrast among average differences through an ANOVA analysis. Regions have been divided into three groups: those ones which

21 These data are available at NUTS-1 level.

22 In times of economic uncertainty or recession, typically business investment in fixed assets will be reduced, since it ties up additional capital for a longer interval of time, with a risk that it will not pay itself off . Conversely, in times of robust economic growth, fixed investment will increase across the board, because the observed market expansion makes it likely that such investment will be profitable in the future.

moved upward; those ones which moved downward and regions that did not experience changes in the period considered. Table 3.2 summarises the averages of the supposed causal variables for each class and the Fisher-Snedecor tests to assess if there are significant differences in means depending on the groups.

Obviously results would be different if we tested different partitions of regions, for instance the winners and the rest or the losers and the rest: in order to detect deeper information, for relevant variables, pairwise comparisons through Tukey HSD (Honestly Significant Difference) tests have been executed and they are shown in table 3.3.

What we can see immediately from table 3.2 is that variables strictly related with population, as fertility and density, are not explanatory factors of the observed differences among the groups selected, whereas migration is U-shaped with no significant difference between winners and losers and we can say that it follows well enough the pattern of final per capita GDP, hence, ex ante, the expected income.

Health conditions, which are significant, are better for losers and not different for the other two groups: they are related with the initial GDP level but result could be also consistent with historical facts that registers worse states of health during processes of economic development.

Initial per capita GDP is noticeably higher for losers, about 4000 Euros more than for the other two group, which have actually the same starting condition. Then the process reduces disparities, which are quite slight among groups in 2007, and leave the central group of not-moving regions back.

The analysis of GDP growth, instead, does not reveal any interesting pattern. Differences are significant among every group and are present in both sub-periods, with the latter in which groups experienced higher rates.

Among variables representing educational levels, the hypothesis that the number of persons who attained at most lower secondary education is the same in every class cannot be rejected. Hence differences among winning regions and the rest emerge in middle and high educational levels: winners show a higher share of persons who are high – skilled and, as consequence, a lower population percentage with just upper

Table 3.2 *Relations between characterising variables and growth performances.*

Variables	Statistics tests		Average values		
	F test	p-value	Downward (73)	Stable (149)	Upward (49)
Fertility	2.74	0.664	1.52	1.53	1.42
Demographic density	0.63	0.532	283	373	463
Migration	7.48	0.000	3.90	2.29	5.16
Life expectation	11.32	0.000	78.4	76.5	76.8
Per capita GDP 1995	12.74	0.000	17048	13487	12627
Per capita GDP 2007	3.25	0.040	25289	22771	26018
GDP average growth 1995-2001	149.91	0.000	3.69	4.83	6.98
GDP average growth 2001-2007	64.08	0.000	4.11	5.01	7.36
GDP average growth 1995-2007	63.43	0.000	3.27	4.67	6.61
Low education	0.78	0.462	33.92	32.28	35.78
Mid education	3.54	0.030	45.86	47.24	39.88
High education	3.77	0.024	19.00	18.78	22.41
Workers in technological sectors	5.32	0.005	30.87	28.65	32.88
Expenditures in R&D	4.30	0.014	1.69	1.38	1.23
Gross fixed capital formation	5.83	0.003	4436	3571	3653
Agriculture employment 1995	9.83	0.000	5.27	11.82	7.98
Agriculture employment 2007	11.28	0.000	3.83	8.49	4.88
Agriculture employment growth	1.49	0.228	-19.37	-12.88	-27.52
Industry employment 1995	3.48	0.032	22.68	20.04	20.60
Industry employment 2007	0.82	0.441	18.54	17.72	16.92
Industry employment growth	5.79	0.003	-17.70	-11.38	-17.93
Constructions employment 1995	1.86	0.157	7.20	7.33	8.03
Constructions employment 2007	27.57	0.000	7.19	7.64	10.09
Constr. employment growth	10.18	0.000	1.41	12.35	29.02
Trade employment 1995	1.93	0.147	24.93	24.43	26.06
Trade employment 2007	2.59	0.077	24.79	24.95	26.45
Trade employment growth	2.57	0.078	-0.13	4.47	2.68
Finance employment 1995	1.60	0.203	10.10	9.29	10.54
Finance employment 2007	2.83	0.061	13.60	11.83	13.14
Finance employment growth	1.42	0.243	35.47	30.33	31.25
Public employment 1995	4.36	0.014	30.16	27.40	27.11
Public employment 2007	5.07	0.007	32.06	29.38	28.51
Public employment growth	2.12	0.121	6.70	9.33	5.75
GVA average growth	60.30	0.000	1.77	2.76	4.17
Employment average growth	9.28	0.000	0.60	0.51	1.21

Table 3.3 *Significance of the differences across group.*

Variables	**Comparisons**					
	Not change – Down		Up – Downward		Up – Not Change	
	Diff.	**p-value**	**Diff.**	**p-value**	**Diff.**	**p-value**
Migration	-1.61	0.052	1.26	0.334	2.87	0.001
Life expectation	-1.84	0.000	-1.62	0.005	0.23	0.871
Per capita GDP 1995	-3561	0.000	-4421	0.000	-860	0.616
Per capita GDP 2007	-2518	0.133	729	0.902	3247	0.081
Mid education	1.38	0.834	-5.98	0.134	-7.36	0.023
High education	-0.22	0.980	3.41	0.066	3.64	0.021
Workers in technological sectors	-2.22	0.150	2.02	0.388	4.23	0.006
Expenditure in R&D	-0.32	0.049	-0.47	0.020	-0.15	0.585
Gross fixed capital formation	-866	0.003	-783	0.052	-82	0.959
Agriculture employment 1995	6.55	0.000	2.71	0.352	3.84	0.740
Agriculture employment 2007	2.17	0.000	-2.18	0.724	-6.49	0.009
Industry employment 1995	-2.64	0.025	-2.09	0.246	0.55	0.882
Industry employment growth	6.33	0.012	0.23	0.996	6.56	0.028
Construction employment 2007	0.44	0.354	2.90	0.000	2.46	0.000
Constr. employment growth	10.95	0.056	27.61	0.000	16.67	0.007
GVA average growth	0.98	0.000	2.40	0.000	1.41	0.000
Employment average growth	-0.10	0.776	0.61	0.003	0.70	0.000

secondary education. Values of tertiary educational level confirm that human capital is a very relevant factor which we must consider in order to explain economic growth and having more persons with high education is a very positive factor to stimulate it.

The same remark can be made about percentage of workers in scientific and technological sectors (that stimulate productions with higher value added), which, in fact, is directly related with growth performances. Nevertheless level of expenditure in Research & Development, which is higher for losers and lower for winners, is an alarm that should push operators and administrators of winning regions to change their policies if they want to support a long-lasting growth. The suspicion that, in some way, GDP growth experienced by regions which moved upward is not so solid is confirmed by gross fixed capital formation which, as said before, it can be interpreted as an

indicator of operators' confidence: it is significantly higher for losers, hence agents have preferred to direct their fixed investments toward old industrialised zones that, to a certain extent, still seem more reliable.

If we move on production structure we first see a generalised decrease of employment in agriculture which leaves unchanged the relative positions of our groups, with winners and losers showing a similar level, lower than that one of not-changing regions: this is not surprising since areas that moved downward were industrialised since long time and areas that moved upward are basically urban areas, in contrast with rural areas which did not experience any significant change in their income.

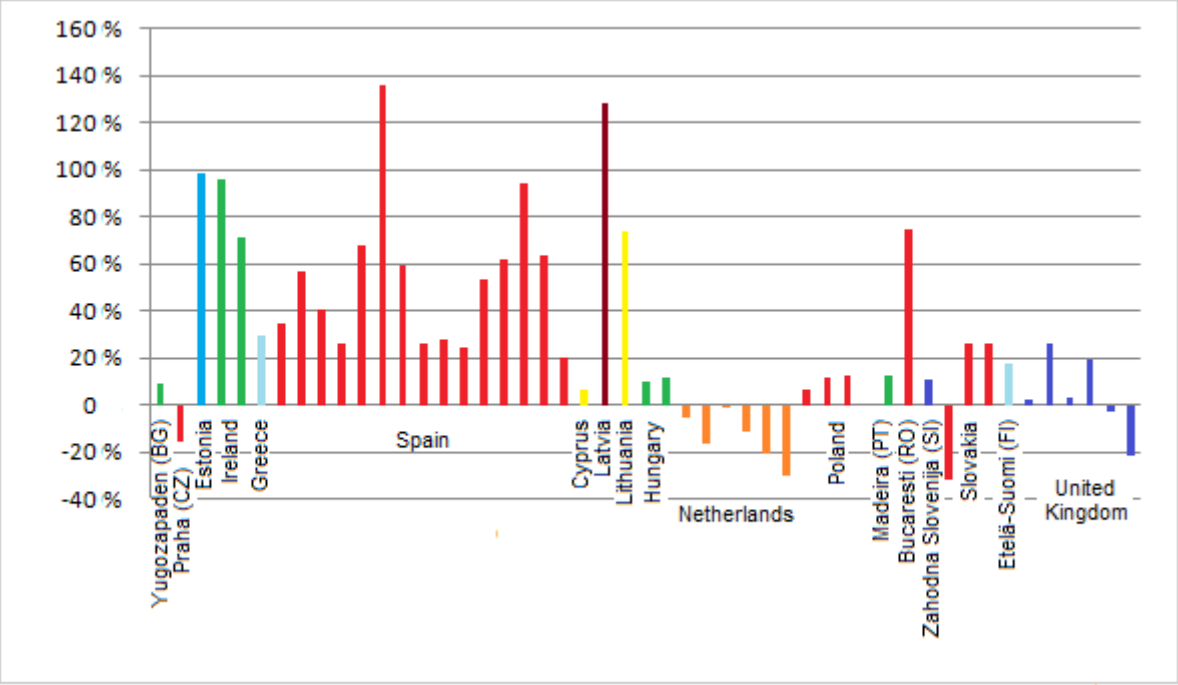
Employment in industry, which at the beginning was obviously higher in European Core Area, has fallen down (less for not-changing regions) and, in 2007, has differences among groups that are no more significant.

3.3.2.1 Role of Constructions Sector

The very relevant variable is indeed employment in constructions: percentages were no significantly different in 1995, but then three classes have had opposite patterns in their evolution: losing regions have seen a slight decrease in the relative weight of this sector; not-changing regions have on average registered an increase of 12% while in winning regions the proportion of workers in constructions rises up to more than 10%, with a net increase of almost 30%. Hence, in 2007, employment in constructions is still not statistically different between areas that moved downward and areas which remained stable, but it is much higher for areas that had a positive movement. Looking at figure 3.3, representing the intensity of changes in such sector, we can observe that, even within winners, behaviours have been very different: Baltic states on average have doubled the size; increase has not been so important in the other CEECs, whereas it is easy too see that the only country that was able to grow, decreasing the share of constructions, has been Netherlands. We should consider that former communist nations, in their transition period, needed in some way to be rebuilt, but this is not true for Spain and Ireland (where maybe there were necessity just for infrastructures): these two cohesion countries which experienced respectively a strong growth and an economic miracle show everywhere big increases in construction up to 136% of La

Rioja and 96% of the Irish area not including the capital (Dublin area growth is 71%). Not less emblematic is the performance of one of European regions historically more affected by unemployment: Andalucía with more than 60%. This production structure analysis makes arise a strong suspicion that many winners have based their performance in sectors, as constructions, that cannot be the basis of a strong productive system able to promote economic growth in a long term[23]. This is confirmed by what has happened after 2007: problems due to property bubbles have caused recession in Ireland and a halt in Spain with a dramatic growth in unemployment and even Baltic nations have registered worse performances than the other CEECs[24]

Figure 3.3 *Growth of construction employment in winning regions.*



Other sectors do not show different patterns in three groups: it is registered a substantial stability in trade employment, a strong increase in finance, and a slighter growth in public sector, but such evolutions do not alter the relative positions of the

23 Investments in constructions (infrastructure) are often a precondition of episodes of extraordinary economic growth, but it seems that this does not alter the long-run growth rate of the regions involved in any significant way, if they do not go with improvement in more long-lasting sectors of production.

24 Of course these crises must be analysed in the global crisis context, but not for such reason they must not be seen in their essence and in their bigger graveness and heaviness.

classes.

3.3.2.2 Productivity and Employment

Finally, productivity evolution has a basic role in explaining the various levels of growth shown by the groups: regional GVA growth differences are very strong and Tukey HSD test provides clear results: winning regions have had higher productivity growth rates whereas losers, although in all cases but one (Severozapaden, Bulgaria) register positive performances, show lower rates than the other two classes.

Moreover, this variable has a greater influence in the long term evolution of regional income. Under this point of view it is possible to point out some common behaviour patterns for winning as well as for losing regions: most of the former (45 over 49) shows productivity gains above average: 25 of them have had a completely virtuous behaviour showing also employment growth above average, whereas other 20 register income growth probably due to restructuring processes (employment growth under the average); the situation is reversed if we look at losing regions where 58 over 73 show GVA rates under average: besides, 25 of them have experienced a more serious situation of economic decline, with both productivity and employment under European average. A resume of these last results is shown in table 3.4.

Table 3.4 *Evolution of productivity and employment in winning and losing regions.*

	Downward (73)		Upward (49)	
Higher GVA and employment	2	3%	25	51%
Higher GVA, lower employment	13	18%	20	41%
Lower GVA, higher employment	33	45%	3	6%
Lower GVA and employment	25	34%	1	2%

3.4 Conclusions

The strong growth of some lagging regions and the average acceptable performances of many Eastern regions, together with the relative decline of most of the core areas are facts which have promoted convergence; on the contrary the relative

stagnation of many old peripheral regions, which have not solved their historical disadvantages (as the Italian Mezzogiorno, Greek, Portuguese and Bulgarian regions), together with the increased concentration of economic activities in big urban areas, mainly country's capitals, have promoted stagnation or divergence. The total result, as shown by analysis of Markov chains for the two sub-periods, is a slowdown of the weak process of convergence among EU regions. Convergence which, analysed with this tool too, indeed appears clearly as a conditioned process.

Considering the variables that can have influenced growth, human resources play a very important and positive role in explaining the observed regional mobility, whereas we cannot say the same about the quality and the size of capital investments which show here almost an inverse relation with economic growth. This is an important finding to take into account that surely has had many repercussions on regional performances in the years following this research. Evolution of productive structure underlines that the main changes in it, the decrease of agriculture and industry and the increase of finance, have had a similar impact everywhere, whereas significant and different changes occurred in constructions are the ones that could explain better the regional mobility, with the implication that this involves. We finally remark the fundamental role of productivity growth, more than employment growth to explain great part of regional gains and losses.

4 The Contribution to Inequality of Between-country and Within-country Components

In this chapter, in order to analyse regional convergence, we come back to traditional tools of regional scientists, which have been lately abandoned in more sophisticated analyses carried out by macroeconomists. To do this, we separate momentarily the study of regional convergence from that of economic growth and we will use Theil Index to measure inequalities. We first introduce such index, then in section 2 we analyse its evolution and its decomposition considering different level of spatial aggregation (community, national and regional). In section 3 it is proposed a different and transversal spatial framework and the findings about it. Conclusions are presented in section 4.

4.1 Introduction to Theil Index

Many researches[25] detect a trade-off between regional and national convergence and suggest that, in European Union, path toward convergence is characterised by increasing disparities among regions within the various countries, that is total convergence is due to the bigger cohesion registered among countries, achieved mainly paying the cost of more inequalities inside them.

To investigate on this hypothesis, in the traditional current of spatial analysis about inequality, we choose Theil Index of concentration: various authors have shown the merits of this index applied to spatial distributions, among which there are its weighting system, its decomposibility and its independence from the number of observations, features particularly useful in a context as heterogeneous as the NUTS2 and in a Union formed both by regions and states of very different sizes.

Theil index is calculated according to the following formula[26]:

25 See for example Duro (2001).

26 Theil index is an absolute value. It is possible to bound it between zero and one in order to obtain a relative coefficient of heterogeneity dividing it by the upper bound calculated by taking the natural

$$T = \sum_{i=1}^{r} y_i \log(y_i / p_i) \qquad [4.1]$$

where T is total inequality among the r regions, y_i and p_i are regional shares of European GDP measured in million of PPS and population respectively[27].

Total inequality can then be disaggregated in between-country and within-country components as suggested by Molle and associates (1980):

$$T = T_{bc} + T_{wc} \qquad [4.2]$$

where:

$$T_{bc} = \sum_{i=1}^{c} Y_c \log(Y_c / P_c) \qquad [4.3]$$

$$T_{wc} = \sum_{i=1}^{c} Y_c \left[\sum_{i=1}^{r} \left(\frac{y_r}{Y_c} \right) \log \left(\frac{y_r}{p_r} \frac{P_c}{Y_c} \right) \right] \qquad [4.4]$$

Capital letters mean here the c country shares of EU income and population.

4.2 Empirical results

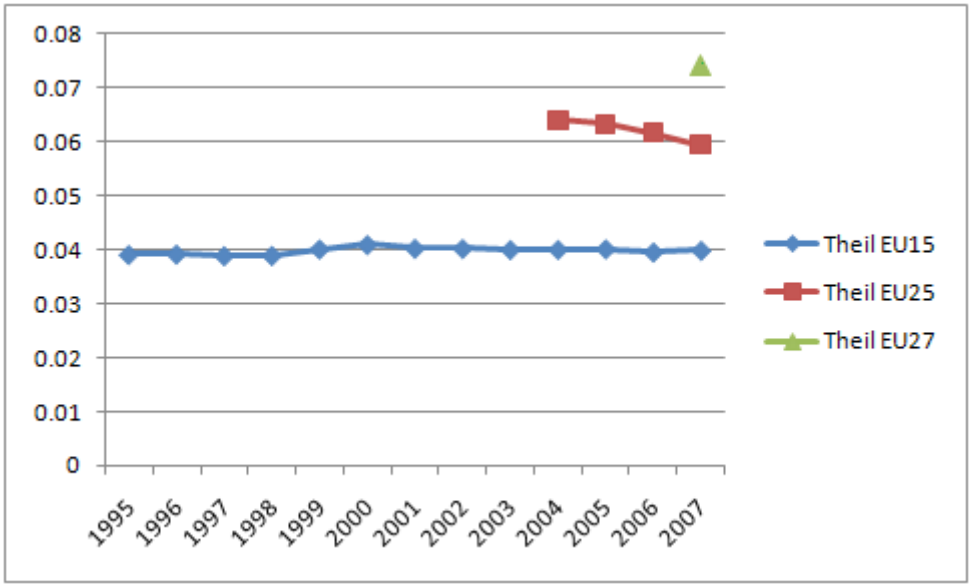
Figure 4.1 shows the time series values of Theil Index for three different sets of data corresponding to subsequent phases of enlargement that EU experienced in the period from 1995 to 2007. We can hence observe what degree of disparity there was in former EU15 including countries of Western Europe; the change in the index due to the entries of 10 CEECs countries in 2004 and finally due to the inclusion of Romania and Bulgaria in 2007. In this way we can follow each group of countries from the entry year until the end of the period: this allows to concentrate our attention on the effects of

logarithm of income, however to our purposes it is not fundamental.

27 A dual form also exists, where income and population shares are interchanged, but here it is appropriate to weight the contribution of each region to inequality by its economic rather than by its demographic strenght.

integration process on regional convergence.

Figure 4.1 *Evolution of Theil Index during different stages of EU integration.*



According to Theil Index, regional inequality in EU15 remained basically constant during the whole period: there are some very slight phases of increasing and decreasing disparities, but long term trend is clearly stationary. We might argue that the 15 countries that were already together in 1995 had previously reached an equilibrium in terms of regional inequality.

In 2004, when CEECs10 joined the Union, the total index had a dramatic increase, but since then the trend of EU25 has been toward convergence with an equilibrium that does not seem near, considering that the rate of reduction of T has not been slowing down.

Finally, in 2007, a new consistent increase was registered: observing that regions which entered were only 14 over a number of 257 in EU25, we can realize the great extent of the different levels of income present in Romania and Bulgaria.

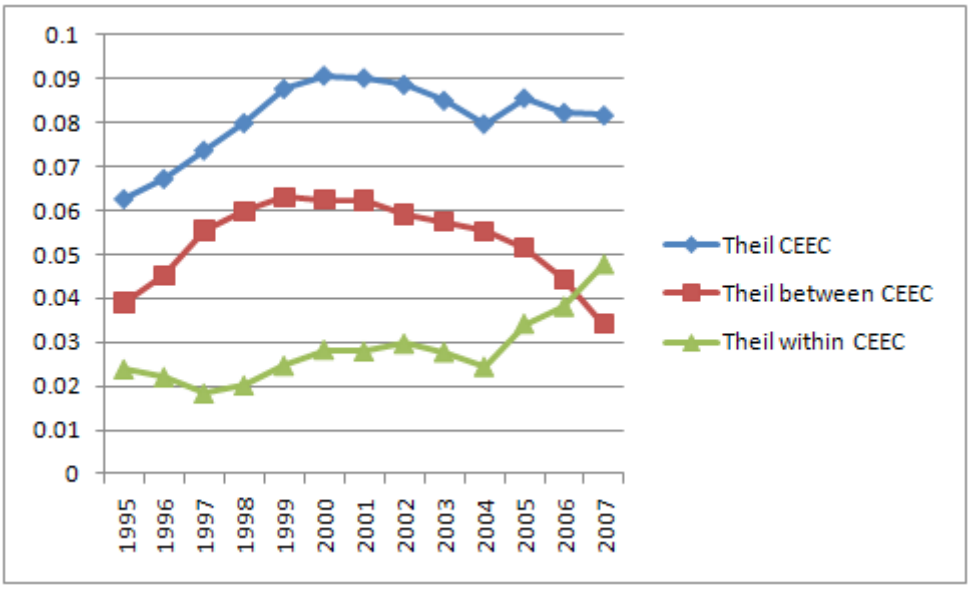
From this initial analysis we can conclude that EU regional convergence, occurred in the last years, seems basically determined by the entry of the less developed former communist countries[28].

28 Also Malta and Cyprus (NUTS-2 corresponding to NUTS-0) pertain to the group of CEECs despite their different locations. Besides they were not part of the communist block, but you will forgive this

4.2.1 Central and Eastern European Countries

We observe what happened in these countries by watching at figure 4.2 which shows evolution of Theil Index since 1995 considering them alone and its decomposition.

Figure 4.2 *Evolution and decomposition of CEECs Theil Index.*



Changes in these countries were many and of relevant size:

1. After the end of communism, inequalities among CEECs increased rapidly, registered a halt around the year 2000 and then took the opposite path toward less disparities with an accelerated trend especially after 2004, when most of them joined EU.

2. A very different pattern is shown by the within-country index which is relatively stationary and quite low until 2004 and then had a strong impulse of constant growth that had not finished yet at the end of the period considered. This is the first clue that pushes toward the assertion according to which the participation in

imprecision if you consider their modest weights in terms of population and GDP over all the regions that lately entered in the Union.

the EU causes increasing disparities within its countries.

3. The total result is affected by the two components in a various way: between-country component has been predominating during all the period but the last year, when there was the overtake of within-inequalities. Path toward convergence among these regions that started in the new century was interrupted only during one year, but with such a growth of within-country index, convergence is not very fast. Nevertheless, considered the small size of almost all these countries (a remarkable exception is Poland and to a lesser extent Romania) we could claim that the main attention should be paid to between-country inequalities and, according to this, be a bit more satisfied in terms of convergence.

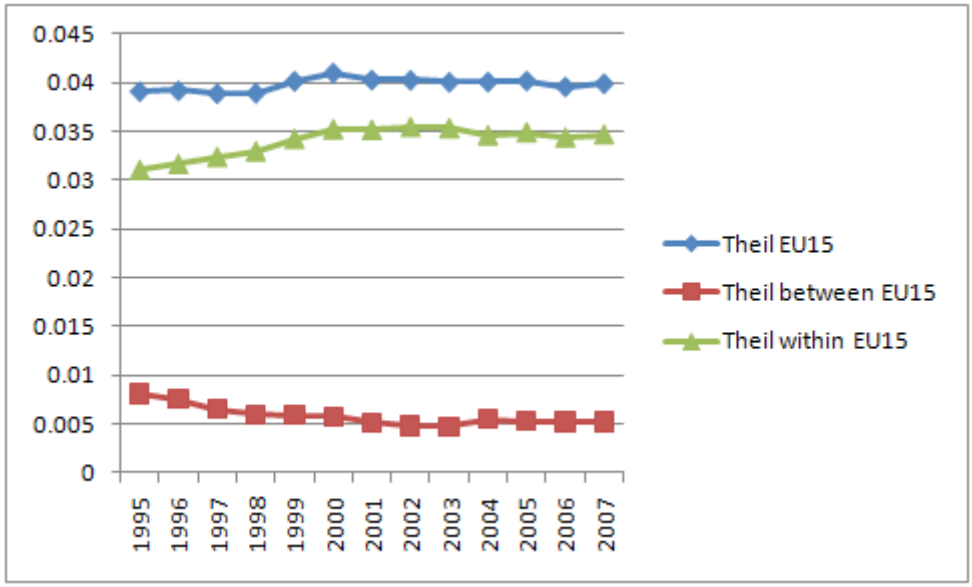
4.2.2 EU15

If we move to EU15, what we can see, as shown in figure 4.3, is very different, since the situation of equilibrium of total T reached is the result of a predominant effect of the within-country index and very low disparities among countries. Moreover, variations in the two components occurred only in the first half of the period considered and were not so strong as for the CEECs, but the direction was again toward a growth of inequalities within-country, compensated by a decrease in the between-country component. For these countries, the most of which joined European Monetary Union (EMU), it seems that this happening has stopped not only the variations of total Theil which was already still, but especially the modification in its composition.

4.2.3 EU27 area

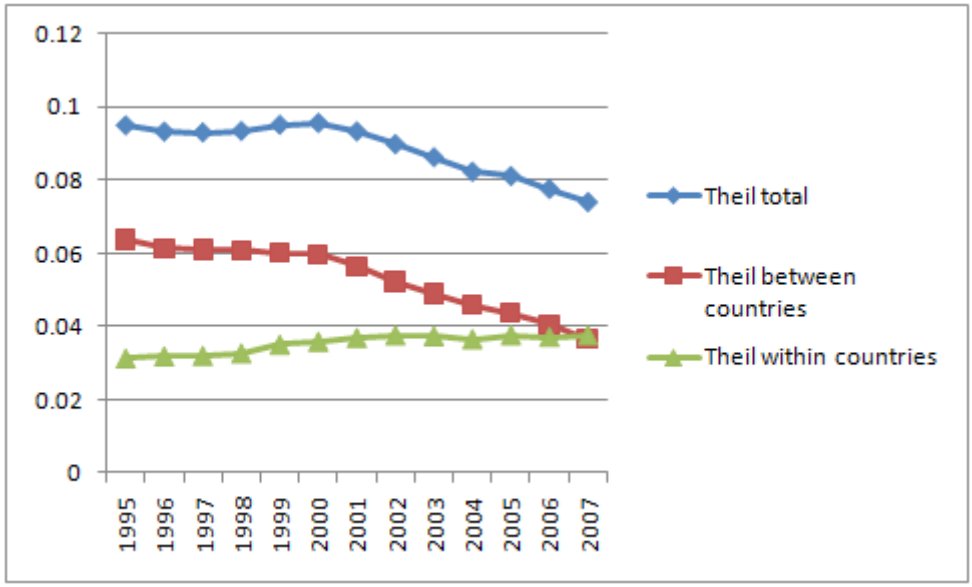
The joined effects of inequalities in CEECs and EU15 are shown in figure 4.4, where it is represented the evolution of total T and its decomposition referred to all the regions that today are taking part in EU27. A resume of the most significant results is highlighted in table 4.1.

Figure 4.3 *Evolution and decomposition of EU15 Theil Index.*



1. Between-country inequality had the most important role in 1995, contributing to total Theil for 67%. Its value had been already decreasing very slightly in the late 90s, but after 2000 negative trend, with a uniform speed, started to be more substantial.

Figure 4.4 *Evolution and decomposition of Theil Index (EU27 area).*



2. Within-country inequality, on the contrary, has slightly been growing up every year up to 2001, from 0.0312 to 0.0369, then has been remaining stationary in the second part of the period considered.

3. The joined effect shows a pattern of total Theil which oscillates between 0.093 and 0.095 in the first 6 years: this is the constant result of the slight decrease and increase of respectively T_{bc} and T_{wc}; then the value falls to 0.0741, according to the diminution of between-country inequality, since the within-country did not register relevant movements.

4. In terms of composition, the importance of T_{bc}, which was double than T_{wc} at the beginning, diminished to 1.5 times in 2001, at the end of the first sub-period characterised by opposite slight movements, and dropped toward parity in the second sub-period, with a significant overtake of within-country inequality in 2007 due, however, not to an its own increase.

Table 4.1 *Values of total and decomposed T.*

Year	T	T between-country	T within-country	Between	Within
				Total	Total
1995	0.0949	0.0637	0.0312	0.671	0.392
2001	0.0933	0.0564	0.0369	0.605	0.395
2007	0.0741	0.0365	0.0376	0.492	0.508

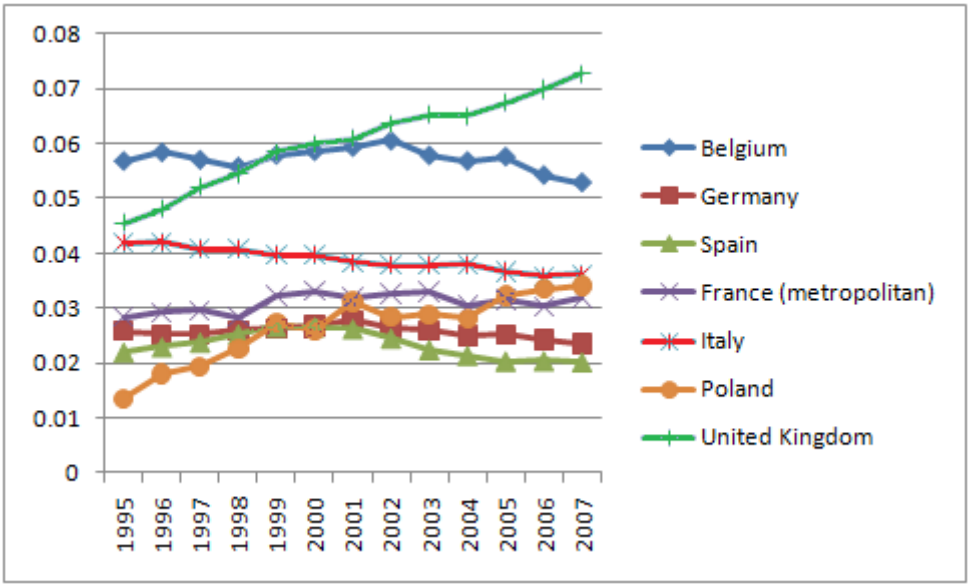
In conclusion, the entry of CEECs and the effectiveness of EMU had the effect of reducing disparities among countries. Inside the countries, inequalities grew limitedly, but significantly if we consider it in relative terms. The hypothesis according to which all the convergence among the regions at European level is explained by the convergence among countries cannot be rejected. With respect to the direction of the inequality within the countries, more light can be shed on the issue looking at what happened inside the biggest European states.

4.2.4 Cases of within-country inequalities

In figure 4.5 it can be seen the evolution of Theil Index inside the big six countries which in 2007 represented 70% of EU population and 73% of its income. We have added also Belgium which, as we have seen in section 2.4, in spite of being small, has political problems due to its dual economy.

Results about inequality calculated with this index confirm some fact commonly known, but at the same time they reveal some situation or evolution a bit more surprising: looking at the levels we find that Belgian disparities are very high relatively to the country size and even if in the last years they have decreased, they are still important. The most inequal among the big 6 is the United Kingdom where the richest region – Inner London – has its per capita income about 4 times higher than the poorest, Cornwall. Then, as expected, there is Italy. In 1995 the three countries we have just mentioned had high inequalities, then there were France, Germany and Spain with a similar medium degree of inequality and finally Poland with a satisfactory homogeneity among its regions, probably an heritage of the previous regime. Then, during the period considered we have been witnessing a constant increment of inequality within the UK that in 2007 had grown of more than 50% with respect to 1995. The same trend, but less constant, is shown by Poland, which, with market economy, experienced almost a

Figure 4.5 *Inequalities within-country of Big 6 and Belgium.*



triplication of its regional disparities. On the contrary, we can observe a better situation in Italy, due mainly to a strong relative impoverishment of the north and not to the growth performances of Mezzogiorno, which, actually, have been quite mediocre. France is instead a particular case, since all of its inequality is due to the income of its capital city, without which the country would be an example of minimum disparities. Germany after the unification process, which gave initially a strong impulse toward convergence has not registered any further improvement after 1995. Finally Spain, that experienced a growth of inequality in the first sub-period, changed its trend and, in the last years considered, the value of Theil Index is stationary around 0.02, similar to the initial value, which allows the Iberian nation to be the most equal of the big 6. As a result of these evolutions we observe that in 2007, with the exception of the United Kingdom, there seems to be two groups of big countries showing a similar degree of inequality inside them: the first one, formed by Germany and Spain, with low disparities and the second one, made up by Italy, France and Poland, which were converging toward the same medium value of T and have been remaining around such value during the last three years of analysis.

Coming back to our initial purpose to explain total inequality within-country through the Theil Index inside the big 6, we can claim that the slight growth of T_{wc} is mainly caused by the sum of the increasing trend of the United Kingdom and Poland slightly lessened by the result of Italy.

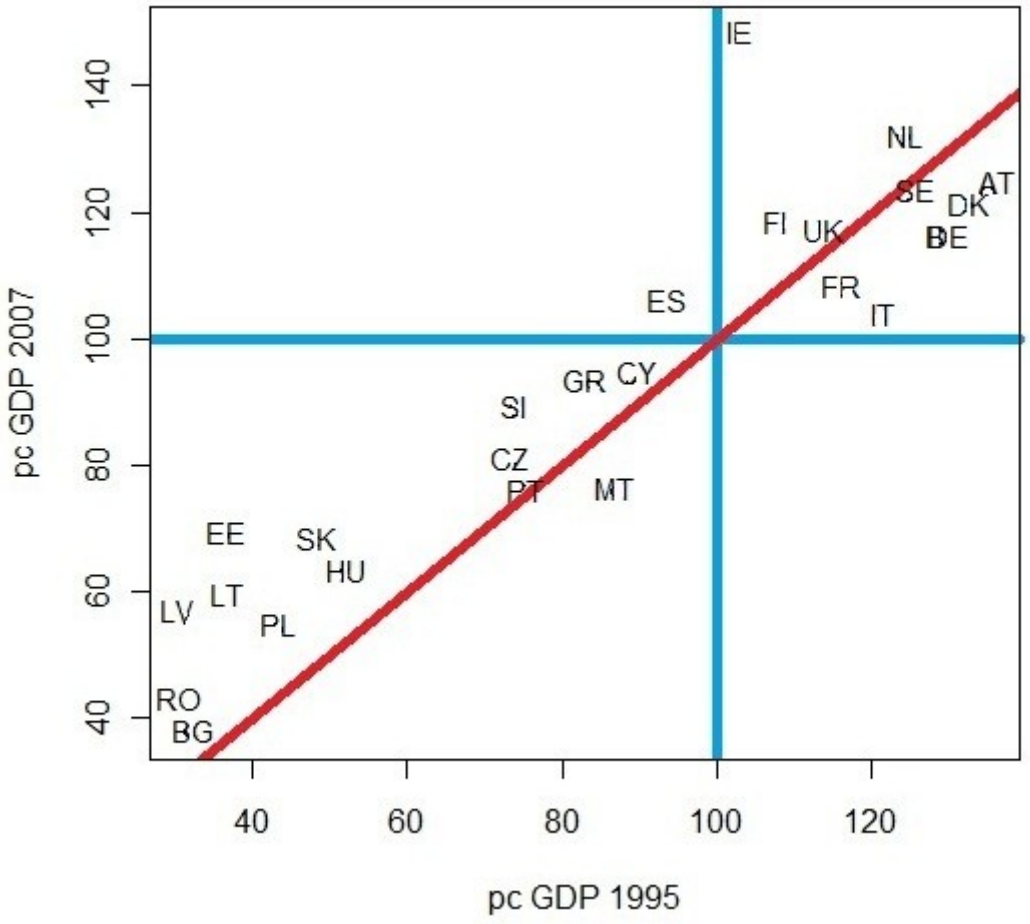
4.2.5 Between-country inequality

On the other side the reduction of inequality between-country can be observed looking at the figure 4.6 which shows the changes in the levels of national per capita income occurred in EU27 (Luxembourg excluded as an outlier) in the period considered. We can easily note that among countries which in 1995 were below European average, representing 1/3 of EU population, all but Malta – which has insignificant demographic weight (0.08% of EU) – in 2007 had reduced their distance from the mean, since their positions lies over the main diagonal. If we turn our glance to countries above average we see that evolution is not only toward the mean, but such movement involves countries representing almost one half of European population,

whereas richer countries which lies over the main diagonal represent only 17.6% of the inhabitants of EU.

After these clarifications we can conclude that the reduction of inequality between-country is the result of the joined effects of the relative growth of all the countries below average and of the different movements of the countries above it, the most relevant of them indeed converging.

Figure 4.6 *Relations between national incomes in 1995 and in 2007.*

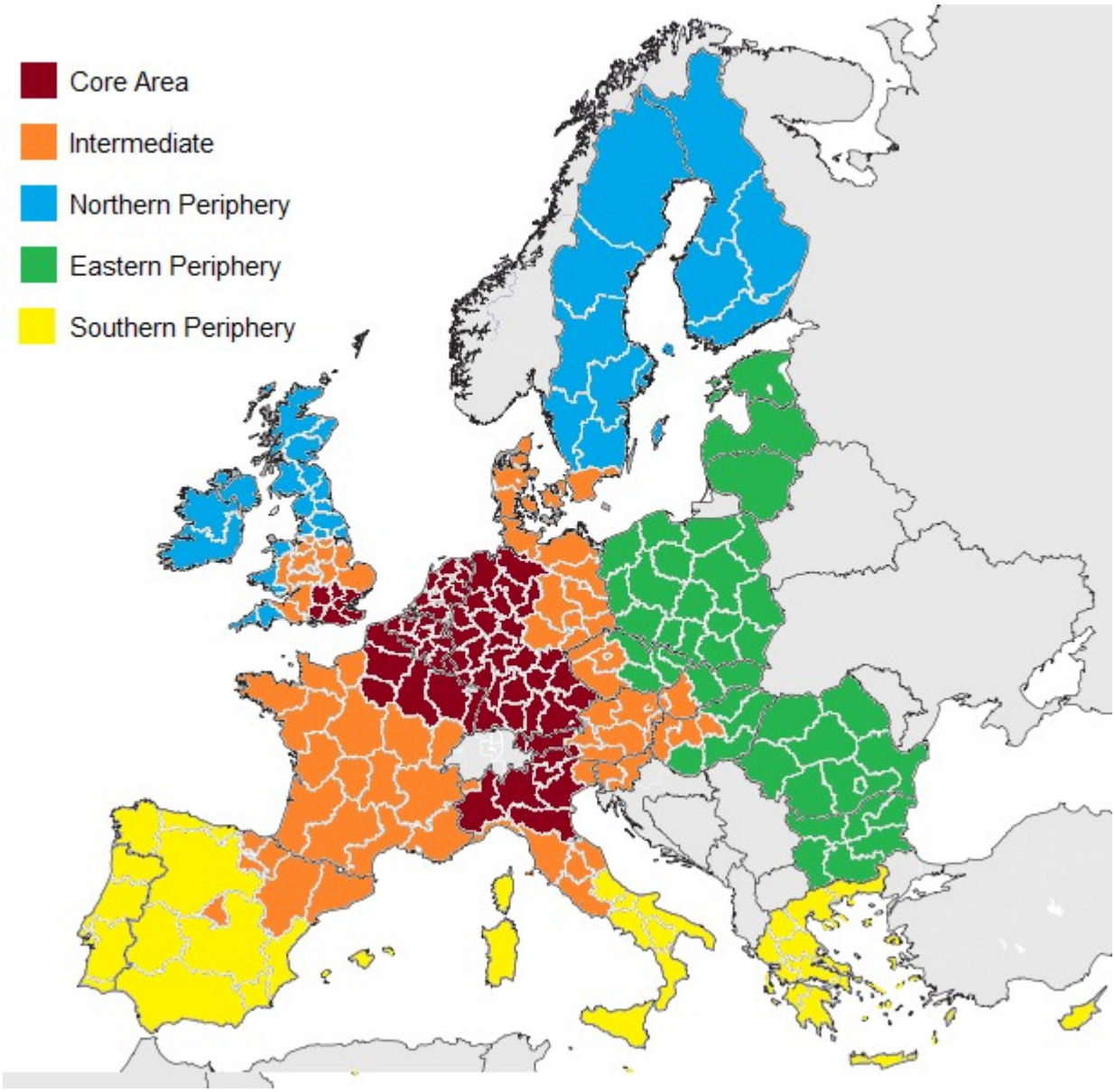


4.3 Regional Convergence analysed among Macroareas

In chapter 2 we had found that spatial factors in terms of either a core/periphery, north/south or east/west dichotomy have a great importance in order to explain differences and inequalities among European regions. But previously we had considered

spatial factors inside the countries, whereas now we are going to carry out a different analysis with the purpose of establishing whether a meaningful macrospatial structure exists in European Union and whether it has more relevance with respect to areas delimited by national borders. The emergence of macroareas is exactly what could happen in a more integrated Europe in which national borders will become less important and regions will interact directly with each others.

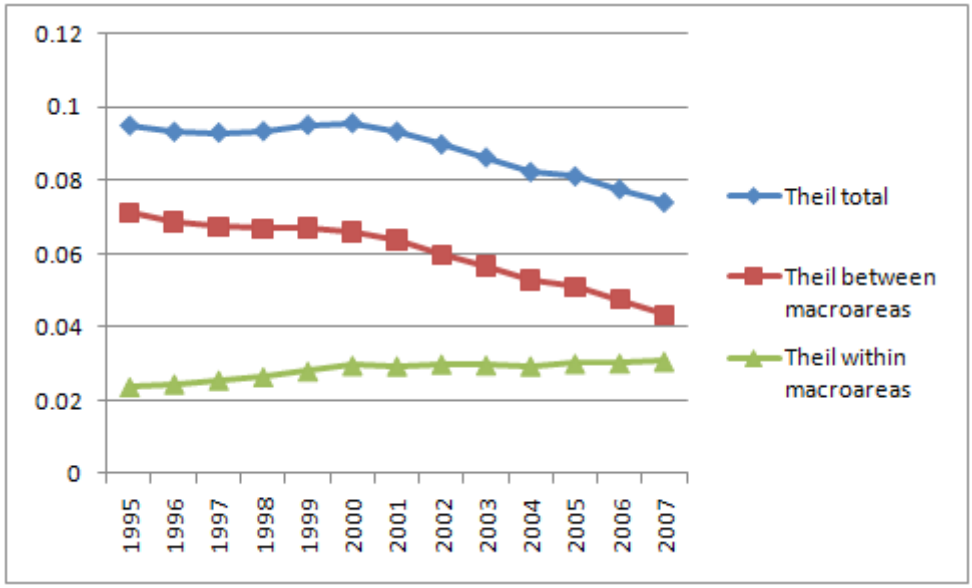
Figure 4.7 *Map of European macroareas.*



A core/periphery structure is generally identified through the concept of economic potential. About the same topic, Peschel (1981) suggests that the distance variable could be interpreted as a proxy for historical, cultural and linguistic influences. If we consider this, a similar value of the economic potential can have very different impacts in Northern Ireland, Andalucía or in the region of Bucharest. Then it appears adequate to combine the peripherality of regions in terms of economic potential with their cultural and historical background, which might be reflected in northern, southern or eastern location. The borders chosen to bound the resulting macroareas can be seen in figure 4.7.

The inequality emerging form this classification are shown in figure 4.8. We can note that between-macroarea component covers the greatest share of total T, going from 75% in 1995 to 58.5% in 2007. From the comparison of this share with the one of the previously found between-country component during the same period, we observe that the former was less relevant, but both have been losing weight actually at the same speed, hence the pattern of macroarea and country structure is similar, but with different levels reflected by different component shares: macroareas have less disparities within them, id est they are more homogeneous than countries.

Figure 4.8 *Evolution and decomposition of macroareas Theil Index.*



If we would like to look at such degree of homogeneity inside them we can observe figure 4.9, which shows the calculated Theil Index for each of them. The macroarea with the highest intra-inequality is the Eastern Periphery which also shows a controversial trend, initially increasing, then decreasing and finally stationary around 0.05. This reflects the effects of the epocal changes occurred in this area in the years immediately before our analysis and during it. Stronger inequalities are present also in the Core Area: evidence that a process of further concentration of activities and income is registered also inside the richest core of Europe, an area which goes from the Po Valley to Southern England passing through Rhine Valley and including Paris, Île de France.

Inequalities have also grown where they were very little, such as in Northern and Southern Peripheral area, whereas the only area where inequality has decreased is the Intermediate one, an example of satisfactorily uniform distribution of income among regions which have a good level of wealth.

The evolution of the macroareas' situation in terms of income and population during the period 1995-2007 is resumed in table 4.2.

Figure 4.9 *Inequalities within-macroarea.*

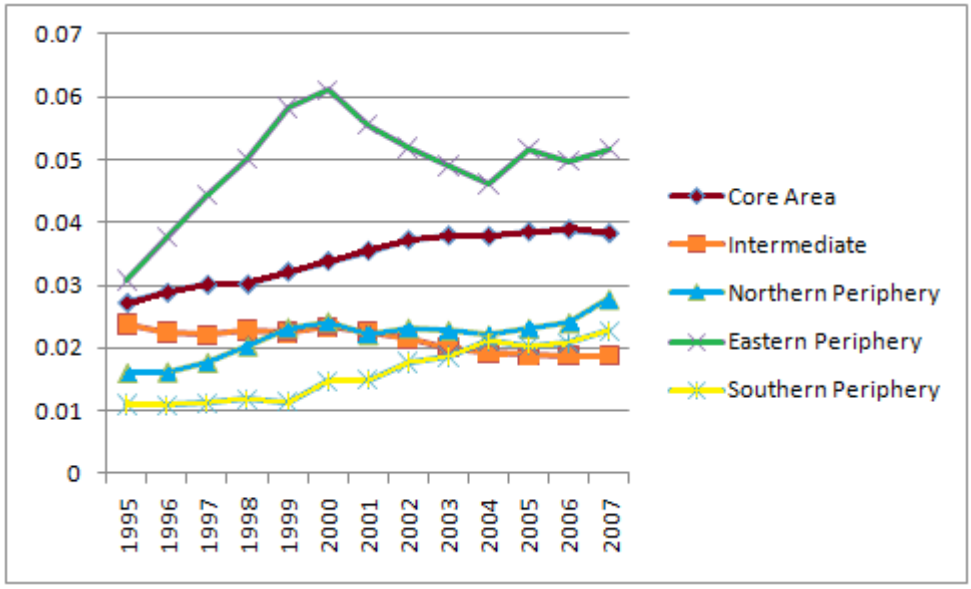


Table 4.2 *Evolutions of income and population of macroareas.*

Area	Per capita GDP (EU27=100)		Share of EU27 income		Share of EU27 population		% changes in shares	
	1995	2007	1995	2007	1995	2007	income	population
Core	140	130	0.430	0.404	0.308	0.311	– 6.0	1.1
Intermediate	107	105	0.304	0.303	0.285	0.289	– 0.2	1.3
North	106	111	0.080	0.084	0.075	0.076	5.4	0.7
East	39	50	0.074	0.089	0.190	0.178	19.2	– 6.2
South	79	82	0.112	0.120	0.143	0.147	6.8	3.1

The only area that has not been converging is the North. However such macroarea represents less than 10% of EU, whereas the others have been drawing near the average with a speed which is directly proportional to their initial distance from it. It is also worth remarking that Northern Periphery appears already completely integrated in Intermediate area, not suffering further negative forces due to its peripherality.

These results seems supporting the hypothesis according to which a delimitation of European borders on the basis of macroareas reflecting various degree of centrality and cardinal location has gained weight in comparison to the traditional national borders and could usefully substitute countries both in studies about regional convergence and as a basis for delineating regional policy strategies.

4.4 Conclusions

We have examined the issue of regional convergence with a different approach, using a traditional tool: the results obtained with this simple method are not completely different from those shown by the more sophisticated ones. There is convergence and if we consider the whole EU27, this has occurred mainly in the second sub-period, with the entry of the regions of CEECs, that indeed have increased inequalities in EU but basically are the most accountable for a positive path of integration, more than the Western ones which seemed to have already reached a situation of stationary equilibrium of their own inequalities.

The conclusion of the decomposition that the chosen index allows is that the main responsible of the convergence is a strong reduction of inequality measured at country level, whereas within-country disparities among regions have slightly increased.

We have then examined the most interesting single situations which let us to realise that under this point of view the panorama is very heterogeneous, comprehending movements in every direction. We think that a special attention should be directed toward preventing national convergences at the expense of regional divergences.

Finally, we should have brought some evidence in favour of an alternative spatial structure emerged in Europe, transversally to the traditional national borders.

5 An Analysis of the Determinants of Economic Growth through Barro Equations

We finish the review of the different techniques to assess convergence by proposing a method that has been used in many studies by Barro and Sala-i-Martin which mainly consists in setting a linear model where all the possible variables that have some power in explaining economic growth enter. The chapter begins with a description of the framework that leads to this kind of analysis, it continues in section 2 with empirical results about absolute convergence and then, in section 3, it is presented the true purpose of the study, that is the findings about quantitative impact of each variable on per capita GDP growth. Conclusions follow in section 4.

5.1 General and Theoretical Framework

The analysis of circumstances that in different regions can support or oppose economic growth may be structured under another point of view, which still shares with studies about conditional convergence the use of the same equation:

$$\Delta y_{i\,t} = \alpha + \beta \log y_{i\,t-1} + \sum_j \gamma_j S_{j\,i\,t-1} + u_{i\,t} \qquad [5.1]$$

where per capita GDP growth of region *i-th* at time t is influenced also by S, which is a group of j independent variables that can catch regional differences whether of structural or institutional nature; γ is the vector of the coefficients that weight the impact of S on growth.

Such different method – often called "Barro equations"[29] – in fact is not only aimed at assessing net convergence without conditioning variables, but it is more general: it supposes that regions could have both different transitional and different steady state growth rates, but this point is not as relevant as the identification of the

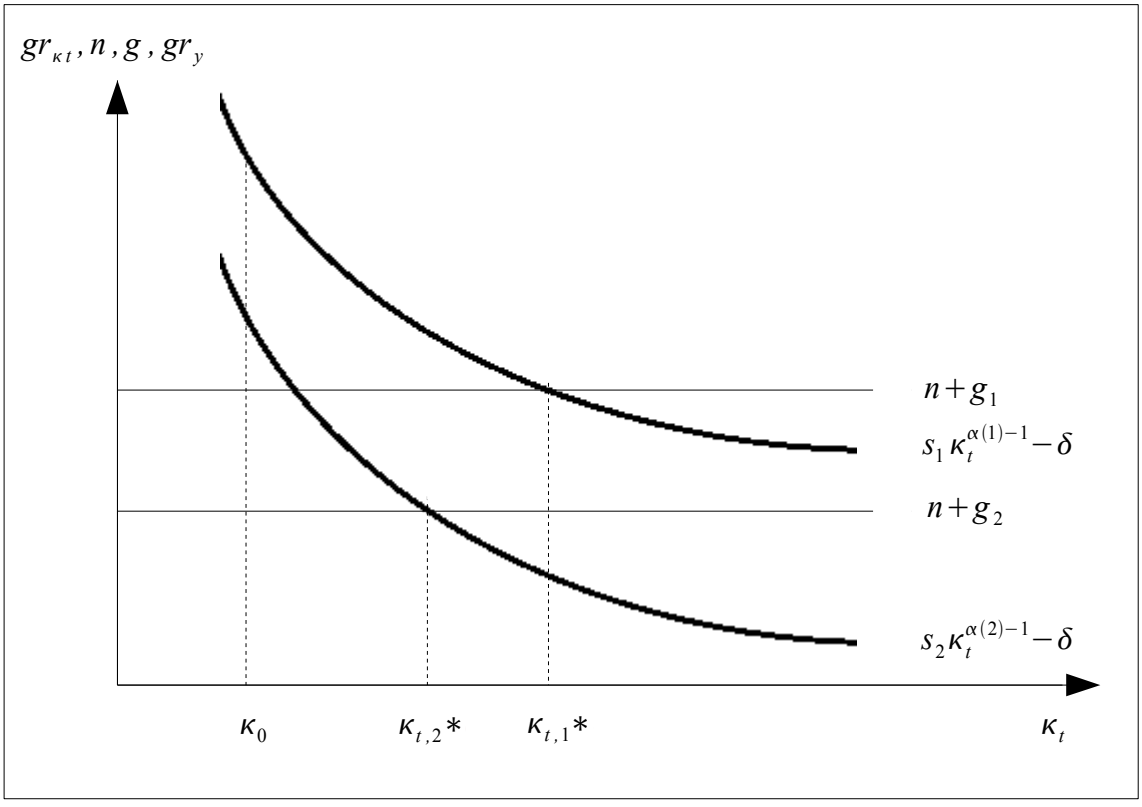
29 Robert J. Barro used it for the first time (1991) .

variables which extend their influence on economic development.

In order to understand this generalisation, let us consider the situation represented in figure 5.1. Here we observe two regions provided of the same initial quantity of capital per effective worker κ_0 that have the following characteristics of their parameters:

- Saving rate is higher in region 1 ($s_1 > s_2$);
- Marginal productivity of capital is higher in region 1 ($\alpha_1 > \alpha_2$);
- technological progress is higher in region 1 ($g_1 > g_2$);
- population grows at the same rate in both regions ($n_1 = n_2$).

Figure 5.1 *Situation of two developing regions having the same initial quantity of capital per effective worker. Region 1 is advantaged whereas region 2 is penalised by conditioning variables as saving rate, marginal productivity of capital and technological progress.*



We can thereby see that region 1 not only maintains always a higher transitional growth rate than region 2, but it converges toward a bigger steady state growth rate too.

In such way it will reach the steady state path $\kappa_{t,1}^* > \kappa_{t,2}^*$ and it also keeps on growing at a constant rate always higher than the one of region 2. Obviously, the parameters and hence their effects, may be mixed variously, but what this approach suggests is that we cannot distinguish between the two kinds of growth rate we have mentioned with equation [5.1]. After all, as we said, this is not the matter, since what we are concerned with is identifying what variables condition economic growth – especially those that could be manipulated with policies – and in which direction.

The way Barro and Sala-i-Martin carry out their analyses is by setting an equation as [5.1]: once a set of variables able to explain growth is chosen, they calculate regression's coefficients and finally they can examine the effect of each variable by studying its relationship with residual growth which remains once the impact of the other variables has been subtracted.

5.2 Absolute Convergence

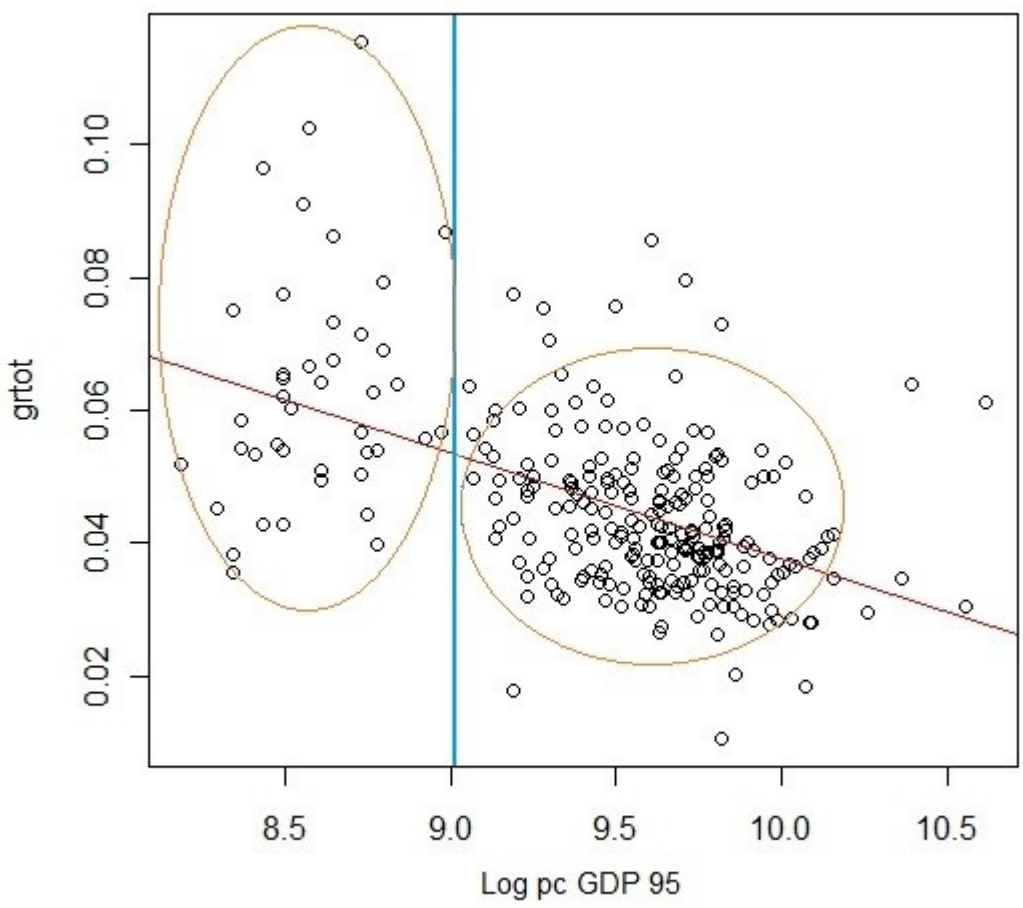
We first examine the plot representing the net relationship between logarithm of 1995 per capita GDP and total economic growth experienced in the period from 1995 to 2007. The difference with the analysis carried out in chapter 2 is that here we do not use panel data. Solow-Swan and Ramsey models predict absolute convergence, that is poorer countries should grow faster and tend hence to catch up to the more developed economies. Such a result implies that growth rate of per capita GDP in the period observed should be inversely related to the initial level of per capita GDP registered in the same regions.

Figure 5.2 shows that these data do not allow to reject the hypothesis of absolute convergence. The correlation between the two variables is indeed negative, – 0.52, although, observing better, if we split up countries in two cluster, as highlighted in figure 5.2, it seems that all the correlation could be explained by the difference between the clusters, while correlation is virtually nil inside the clusters (actually slightly positive among poorer regions).

In short we find clues of absolute convergence, but the phenomenon has a peculiar outline and it is fundamental to examine the overall impact of the other

variables on growth.

Figure 5.2 *Simple correlation between growth and level of GDP.*



5.3 Conditional Convergence

5.3.1 Other variables influencing growth

Barro's empirical framework relates per capita growth rate to two kinds of variables: initial level of state variables, basically the stock of human and physical capital present in each region; and a number of control or environmental variables which reflect various demographic conditions, political situation, structural characteristics of the territory considered and so on.

The function for regional per capita growth rate during period t can be written

as follows:

$$\Delta y_t = f(y_{t-1}, k_{t-1}, h_{t-1}, env_t, ...) \qquad [5.2]$$

where y , k and h are the state variables just mentioned and *env,...* comprises an array of the other influences. Considering both [5.1] and [5.2] we can define a regression's model given by:

$$\frac{\dot{y}_i}{y_i} = const + \beta \log y_i + \sum_m \chi_m K_{im} + \sum_n \psi_n H_{in} + \sum_q \xi_q ENV_{iq} + u_i \qquad [5.3]$$

Empirically, entering 1995 per capita level of GDP in logarithmic form means that its regression's coefficient represents the rate of convergence, since it measures the variation of the growth rate to a proportional change in y_{t-1} . In our regression[30] k and h are represented by:

- average level of educational attainment (EDUL);
- percentage of workers in technological and scientific sectors (TECHSCIE);
- per capita gross fixed capital formation (PCGFCF)[31];
- the interaction between logarithm of initial level of income and the average years of education (GDP * EDU): theories of technological diffusion usually assume that more human capital raises the ability of absorbing new technologies. This happens, for example, when a higher human capital makes lesser the cost of imitating ideas discovered in other places. The interaction means that having a more educated population raises the responsiveness of $\dot{y}/y$ to reductions in initial level of per capita income and thereby the result of such effect, if

30 For a review of the variables, their features and the reasons why they could explain economic growth, see section 3.3.1.

31 Of course, this is not a stock, but a flow. There are problems in the use of data about capital, especially concerning the assumptions about depreciation. Anyway we think that in EU case, capital per worker should be very related with the level of income and its evolution is satisfactorily caught by fixed capital formation. The advantages of taking into account this kind of capital are explained in section 3.3.

coefficient is negative, is a speed-up of convergence.

In the neoclassical models of Solow-Swan and Ramsey, the effects of the control and environmental variables on the growth rate correspond to their impact on steady-state position. Variables included in regression are[32]:

- demographic density (DEN), which can measure if there are scale effects due to agglomeration of people that reflects agglomeration of human capital and economic activities;
- net migration (MIGR), representing the flows of human capital, under a quantitative point of view. This is also the most important variable to define the net increment of population in a Europe which has not significant differences among regions in terms of fertility, birth and death rates: that is the reason why we have excluded them from the model;
- kilometres of infrastructures with respect to regional surface (INFSUR), an indicator of public physical structures that are at disposition of the economic agents;
- the size of financial development (FIN), which can help the availability and mobility of capital and in this way support productive investments that have beneficial effects on growth. The proxy used to measure it is the relative size of the sector over the whole economy;
- the share of public expenditure over the total gross domestic product (PUBEX). It is assumed that this kind of expenditure does not affect directly productivity, but it implies a distortion of private decisions which has negative repercussions on economic environment and hence leads to a lower growth;
- an index representative of the political framework (POL). This index is an adjusted version of the overall political risk rating published in the International Country Risk Guide, including only the dimensions of internal conflict, corruption, law and order and bureaucracy quality. Such aspects are problematic in many ways and with different results, but the basic idea is that they imply a

32 POL, DEM, CRIM are disposable at NUTS-0 level and not at NUTS-2 level.

waste of resources which could be otherwise employed a in more productive way;

- an index which summarises the democratic conditions of the country to which regions pertain (DEM). The effect of the level of democracy on economic growth is very controversial: in literature there are examples which support the hypothesis that having more democracy is a better conditions in order to grow; other authors put stress on cases where a reduction of democracy was a successful strategy to preserve the economy of a country: in fact there are dictatorial regimes that have a fundamental role in assuring stability condition. A general result commonly accepted is that for poorer areas, more democracy has good influences on growth, then the effect lessens and, for richer countries, further increases of democracy have negative impact. That could be the case of EU, which without doubt is made up of countries that at world level have satisfactory quality of their democracies.
- the number of crimes perpetrated (CRIM) to capture security conditions;
- a dummy to indicate that a region has lately joined the Union since pertaining to Central and Eastern European Countries (CEECs). This reflects not only geographical conditions as underlined by the name, but also historical conditions, since with two little exceptions (Malta and Cyprus) this dummy identifies all former communist regimes;
- a dummy to indicate that a region had been receiving structural funds relative to objective 1 (FUND) up to 2006. That is also the simplest way to assess if such funds have had any effect on growth of the receiving regions.

We have excluded some variable commonly used in this kind of regression, because they were not significant in a European framework, even if it was so at world level: that is the case, for example, of health conditions measured by life expectancy; of the differences between male and female schooling and education; of the previously mentioned natural trend of population and so on.

5.3.2 Single variables impact analyses

Table 5.1 shows results from regression made by using equation [5.3]. The regression is applied to a cross-section of the regions which today form EU27, excluded the overseas territories of France, for which there are problem of missing values and their distance from Europe weakens the effect of integration. The dependent variable, once again, is average annual growth rate of per capita GDP registered during the period from 1995 to 2007.

Table 5.1 *Summary of regression.*

Independent variable	**Coefficient**	**t-value**	**p-value**
Constant	0.2053	5.008	0.000
Log PC GDP 1995	$-1.998 \cdot 10^{-2}$	– 3.938	0.000
DEN	$7.884 \cdot 10^{-7}$	1.002	0.317
MIGR	$4.957 \cdot 10^{-4}$	3.443	0.001
EDUL	$8.283 \cdot 10^{-3}$	0.903	0.367
GDP * EDU	$-3.563 \cdot 10^{-4}$	– 1.821	0.070
TECHSCIE	$5.779 \cdot 10^{-4}$	4.241	0.000
PCGFCF	$1.914 \cdot 10^{-6}$	2.441	0.015
INFSUR	$-1.494 \cdot 10^{-4}$	– 4.007	0.000
FIN	$7.483 \cdot 10^{-4}$	3.197	0.002
PUBEX	$-9.330 \cdot 10^{-4}$	– 5.415	0.000
POL	$1.259 \cdot 10^{-3}$	3.063	0.002
DEM	$4.945 \cdot 10^{-3}$	2.751	0.006
CRIM	$-1.296 \cdot 10^{-4}$	– 3.316	0.001
CEEC	$7.314 \cdot 10^{-3}$	1.972	0.050
FUND	$3.078 \cdot 10^{-3}$	1.606	0.109
R^2	0.596		
Number of observations	267		
F-statistic	26.6		0.000

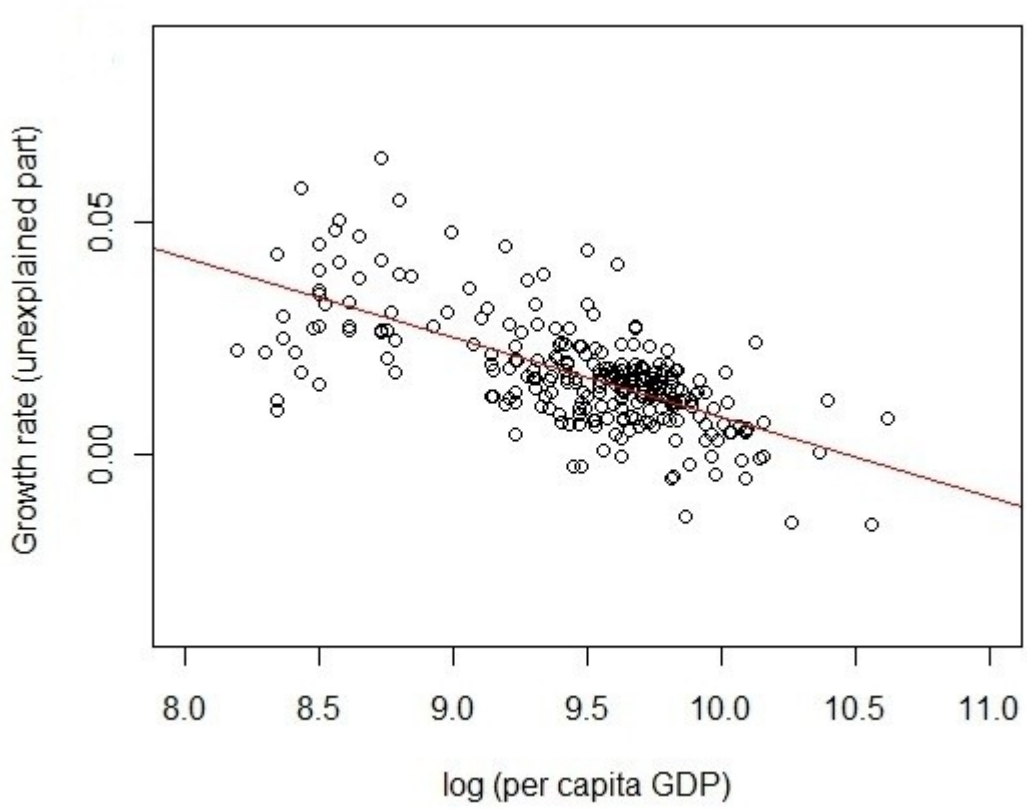
Estimation is calculated with OLS method.

Initial level of per capita GDP

As we know, for given values of the other explanatory variables, the neoclassical model predicts a negative coefficient of initial logarithm of GDP that represents the rate with which economy tends to approach its long-run position. The 1995 per capita income level has an estimated coefficient of – 0.020 (0.005) which is highly significant and represents a conditional rate of convergence of 2% per year[33]. Hence convergence is present and registered but, once again, it is slow and it would take 34 years to get halfway toward the steady-state level of product[34]. In this model, the correlation

Figure 5.3 *Growth rate versus level of per capita GDP.*

In this figure and in the followings the vertical axis shows the growth rate of GDP after filtering out the parts explained by all explanatory variables other than the one indicated on horizontal axis.



33 This is an approximation because the growth rate is observed as an average over 12 years. The corresponding instantaneous rate of convergence is slightly higher than this value (Barro and Sala-i-Martin, 1995).

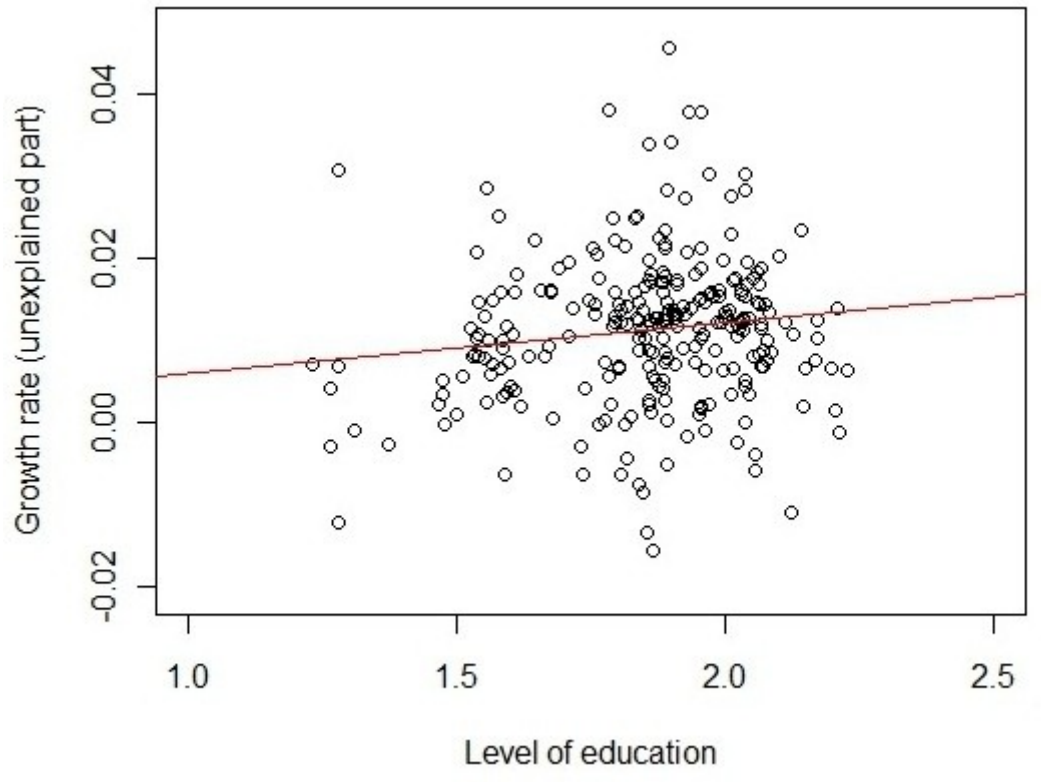
34 Slow rates of convergence have been found in other regional studies about USA states, Canadian provinces, Japanese prefectures (Barro and Sala-i-Martin, 1995).

between initial income and growth has grown until – 0.67 and the better fit is clearly defined in the graph of figure 5.3 that, in addition, allows to exclude that the relation could be non-linear or driven by some outlier. Finally we must say that the correlation of income with the other variables is generally high and its effect can thereby also be caught by them.

Initial level of human capital

Initial level of human capital appears in two variables of the model and in the interaction with income. First, the average level of educational attainment of the regional population from 25 to 64 years old. This indicator is initially measured in four categories, assigning null value to people who has not schooling; one to those who have attained lower secondary education corresponding to level 2 of ISCED[35]; two for who

Figure 5.4 *Growth rate versus educational levels.*

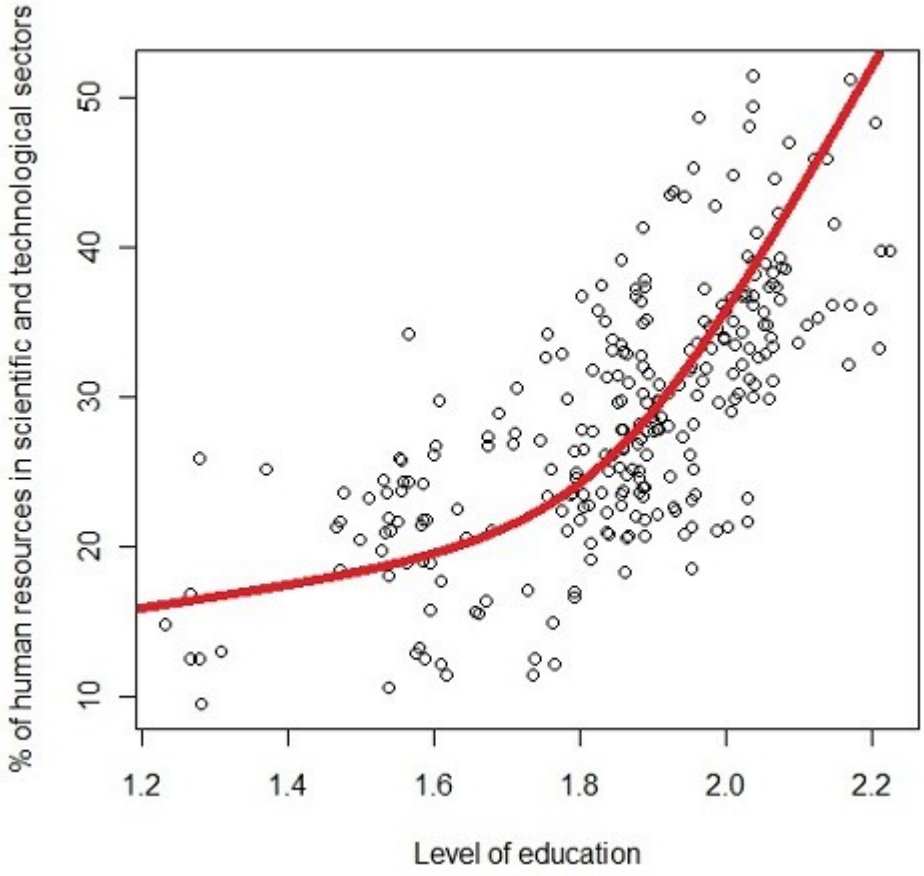


35 The International Standard Classification of Education (ISCED), designed by UNESCO, is an instrument suitable for assembling, compiling and presenting statistics of education both within individual countries and internationally.

has reached upper secondary education (level 3) and finally three for persons who have achieved at least level 5 of ISCED, corresponding to tertiary education. After this the resulting index is just a weighted mean with the size of each group. The regression shows that there is a positive effect of education on growth, but the coefficient is not significant. An extra level of education, which implies at least three further years of school or university, is estimated to raise the growth rate by just 0.8%. This means that what Europe has experienced in the period considered is not a growth based on human capital in terms of school education received. The weak partial relation between education and growth rate (correlation is 0.18) is shown in figure 5.4.

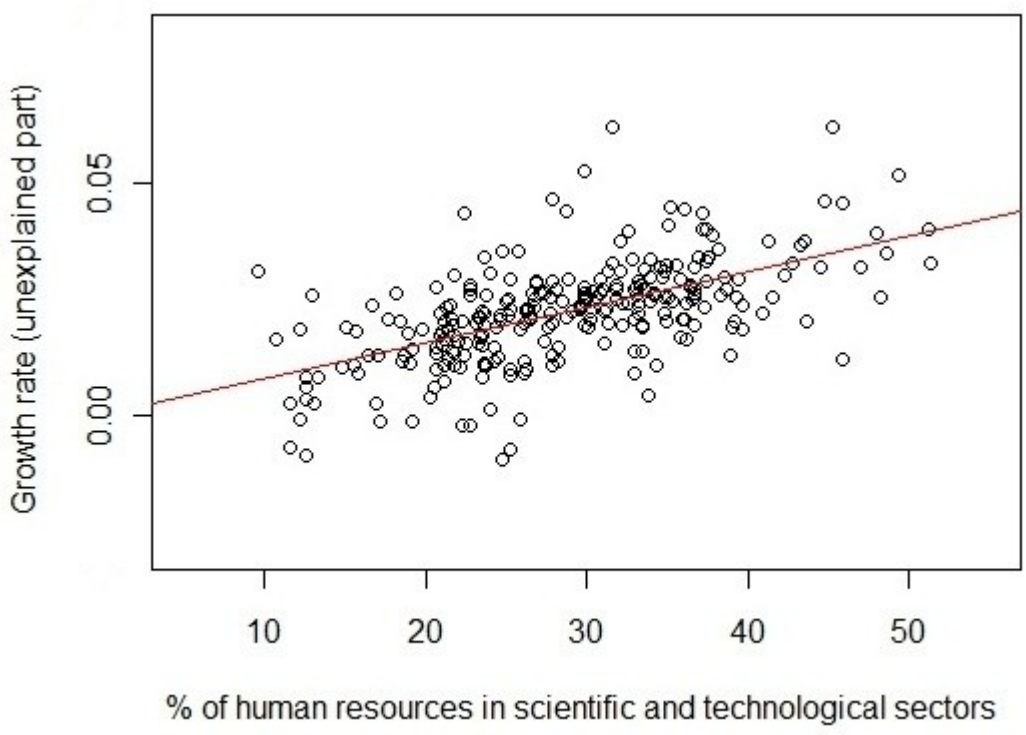
The second variable representing human capital is percentage of human resources in scientific and technological sectors over active population. Its coefficient is

Figure 5.5 *Relation between regional educational levels and human resources in scientific and technological sectors (red line is simply drawn without calculation).*



very significant, 0.00058 (0.00013), therefore if more workers are employed in such sectors, growth will be stronger. It is worth to underline that this variable is very influenced by educational level (the relation is quadratic) which has its repercussions on employment choices: hence we might conclude that there is no direct connection between education and growth, but education acts indirectly on development through the working sectors chosen as consequence of it. In figure 5.5 it is shown the quadratic relation previously mentioned, according to which an extra education has a positive impact that is more than proportional on the percentage of human resources in the most productive and innovative sectors. In figure 5.6 is finally represented the usual partial relation between highly skilled workers and residual growth.

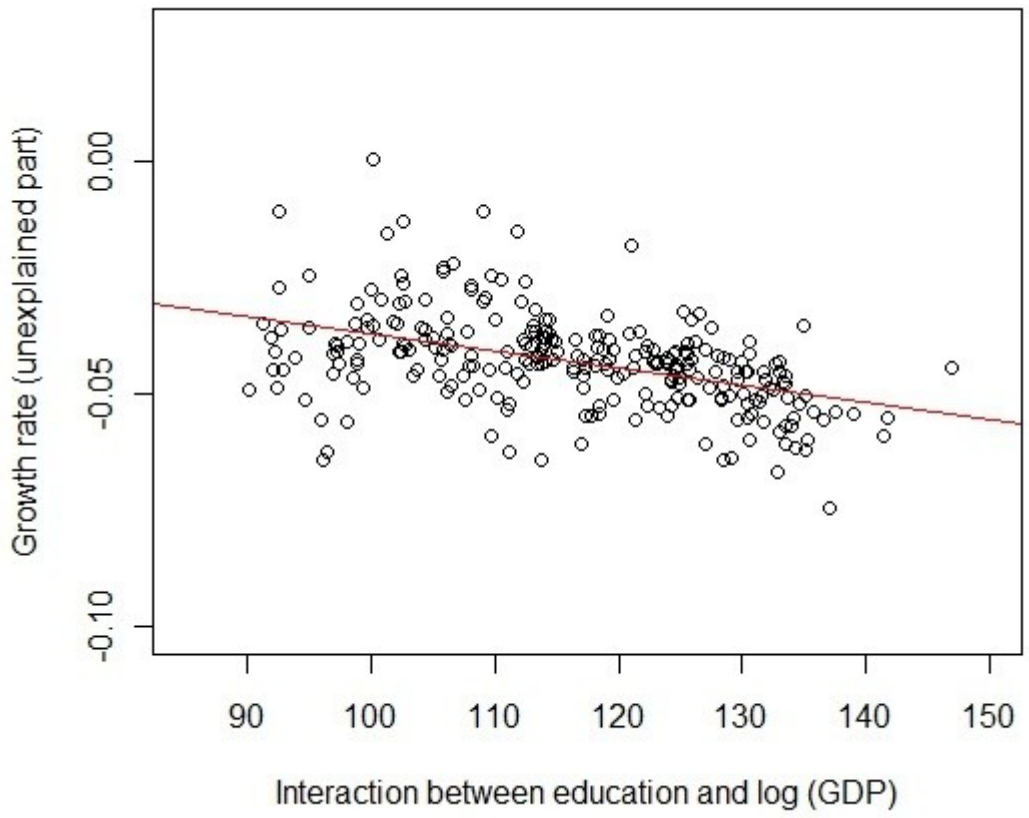
Figure 5.6 *Growth rate versus workers in scientific and technological sectors.*



We complete the analysis of the human capital observing that its interaction in terms of years of education with initial level of GDP is negative (– 0.00036 [0.00020]): it is not a big value, even if it is significant at 10%, but it confirms that the growth rate is more sensitive to log(GDP) when human capital is higher. Such result supports

theories that point out the positive effect of education on a territory's ability to absorb new technologies. The partial relation appears in figure 5.7.

Figure 5.7 *Growth rate versus interaction between education and income.*



We clarify again that measure of health condition, obviously of great importance when we talk about human capital and generally very significant in a worldwide framework, has not been included in the model because its regional differences are relatively of a not relevant extent. With respect to expenditure in research and development – that was used in other studies also as a proxy for assessing the quality of education, integrating the quantitative measures, but that could also be use to include the effort toward innovation of an economy – we found that, in the period considered, there was not any effect of this variable calculated with Barro equations method.

Demographic variables

In the model we inserted demographic density as a proxy able to assess if there are scale effects due to agglomeration of people which in some way implies agglomeration of human capital and economic activities. The coefficient is not significant and it allows to reject the hypothesis that the most urbanized areas have grown more than the rural areas. The lack of correlation, 0.08, can be clearly seen in figure 5.8, which shows the partial effect of demographic density on growth only for regions for which it is < 1000, excluding, among the others, the extreme outlier of Inner London (8377 inhabitants/km^2) that actually can be responsible of the slight slope of the regression line.

Net migration has again a positive coefficient and it has also a significant impact on growth. Generally we are used to observe negative coefficients relatively to the growth of population or fertility rate (proxy for natural demographic trend): this result

Figure 5.8 *Growth rate versus demographic density.*

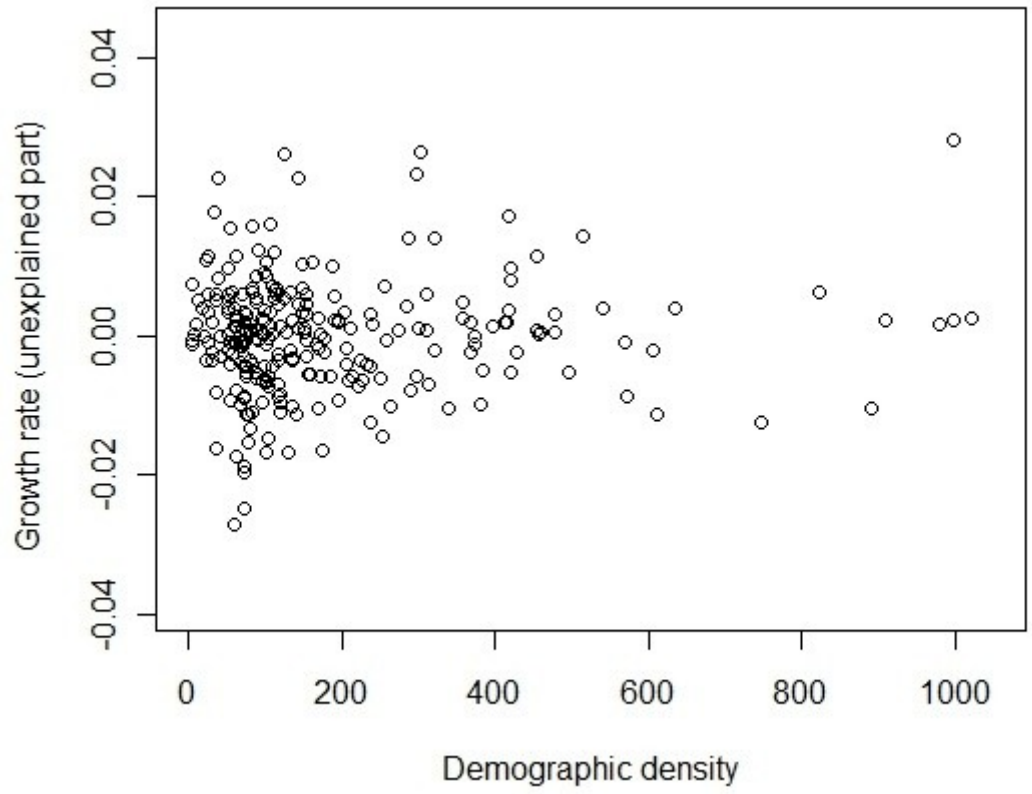
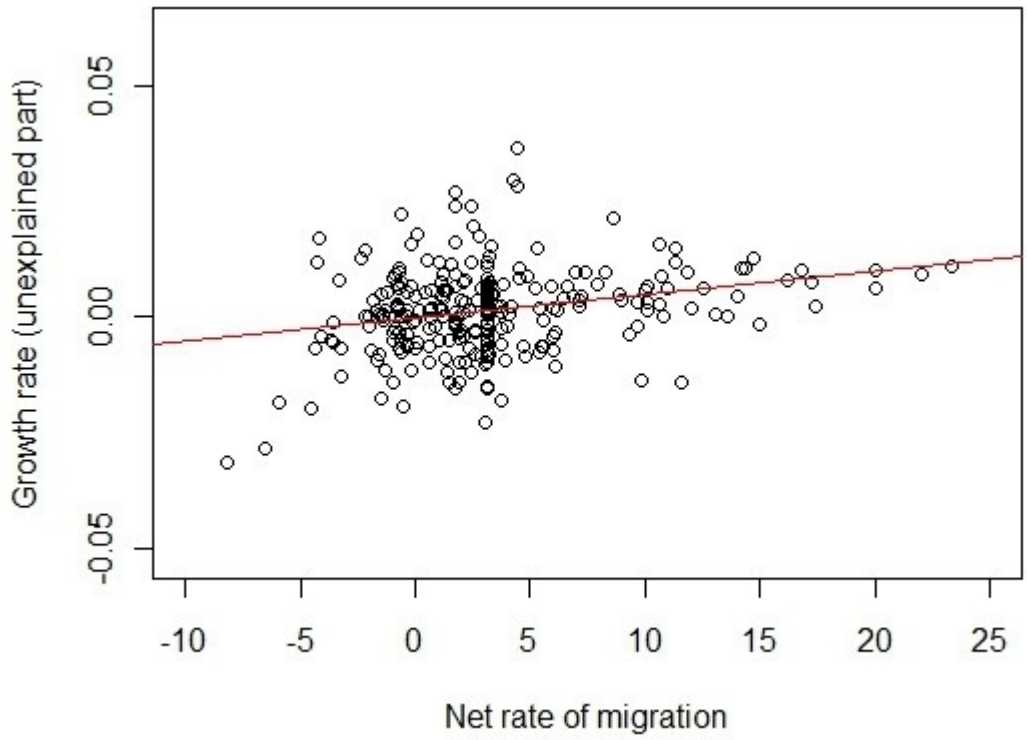


Figure 5.9 *Growth rate versus migration.*



could be trivial if we consider that the variable we are looking at is per capita income. On the other side, migration has peculiar features with respect to natural demographic trend, not only because economic variables that give them impulses are not the same, but especially because when we talk about an immigrant, we are referring to a person who is already skilled – on the contrary of a new born – and hence the argument of human capital enters directly in this demographic topic. A positive coefficient means that the contribution that more immigrants give to an economy is stronger than the negative impact that they have on per capita GDP by simply increasing population. Partial relation between net rate of migration and economic growth is shown in figure 5.9.

Investments in fixed capital

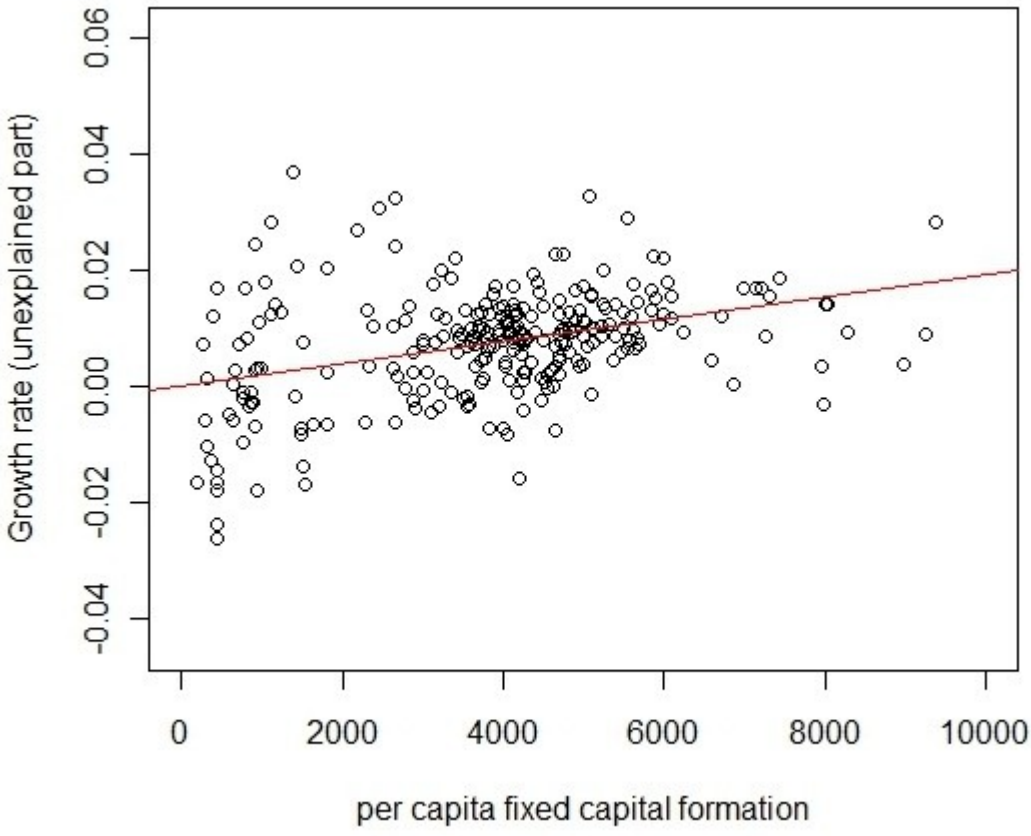
In the neoclassical model saving rate is equal to the ratio of investment. A higher saving rate raises the steady-state level of output per worker and hence increases the

growth rate for a given starting value of income.

We talked about the advantages of considering the fixed capital formation in section 3.3 and in note 22, hence we have chosen to consider it again in this model with the double role of measuring, as a proxy, the total level of investments of each region and catching the evolution of the disposable capital per worker which has a fundamental relevance in explaining growth according to the neoclassical model. The limitations of this variable are that it measures just a part of total investments and we can only assume that such part has a similar size in every region; on the other side, the fixed capital formation does not reveal anything about the already existing quantity of disposable capital in each region and it omits completely the capital depreciation[36].

Another problem which arises when this kind of variables is used is reverse

Figure 5.10 *Growth rate versus per capita gross fixed capital formation.*



36 These latter are matters of difficult estimate even at a country level and it would have been very hard to transpose them to a regional level without the risk to incur in problems or incoherences.

causation, that is a positive coefficient might reflect the positive relation between growth opportunities and investment rather than the positive impact of higher exogenous investments on growth rate. Empirical studies[37] have found that when contemporaneous investment are used as regressor, the coefficient is statistically significant, whereas if it is used as instrument the level of investment in a previous, but contiguous period, the relation is still positive, but it loses significance.

Choosing as instrument an average of the flows of gross fixed capital formation during the first sub-period in order to minimise these inconveniences, its coefficient is positive, significant at 5% but not at 1% and its meaning is that one thousand Euros more of investments in fixed assets raise growth of almost 0.2%: we may thereby confirm to some extent the beneficial effect of the capital formation on economic growth.

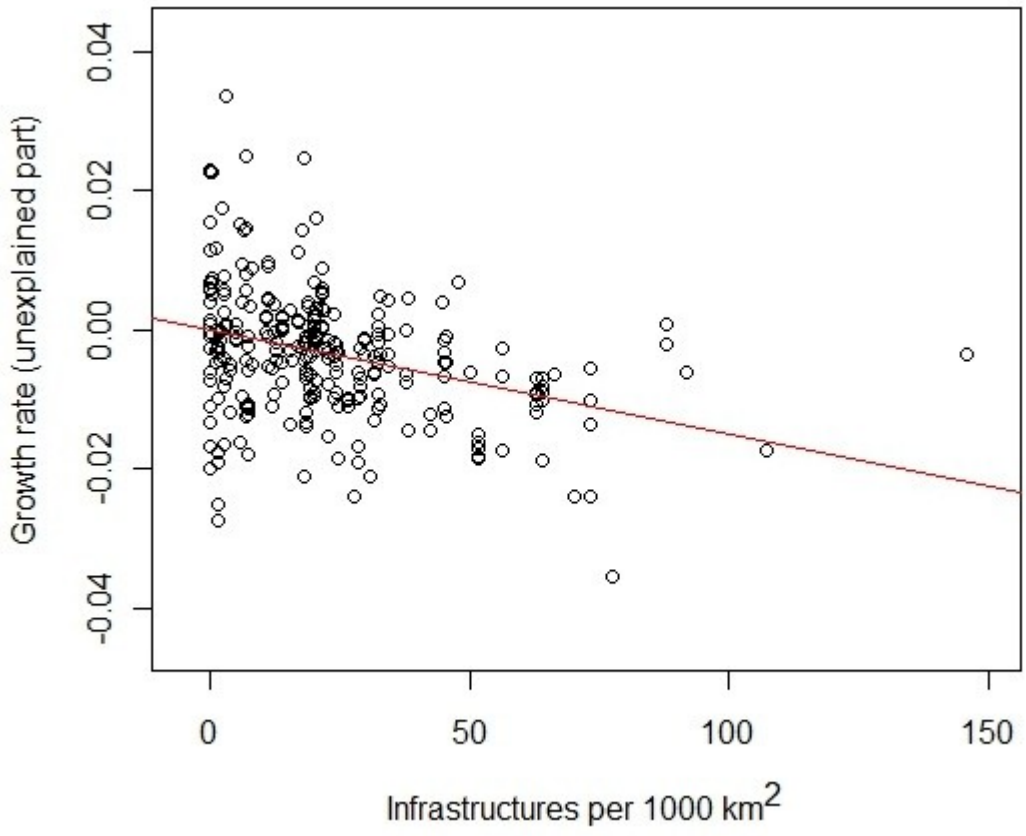
Infrastructures

Maybe the most surprising result of this regression is the negative relation between the presence of transport infrastructures and economic growth, represented in figure 5.11.

We are used to think that more developed infrastructures, through the lowering of cost of transport, stimulate trade and finally output[38]. An explanation of the reasons why economic growth has been stronger in those regions which were less endowed of infrastructures can be found in the new economic geography: as it was stressed by Philippe Martin (2002), there are regions, basically the peripheral ones, for which new infrastructures have the effect to lead them to a further impoverishment: “if we look at the case of industries with economies of scale, a policy to open up peripheral regions may have a paradoxical effect. By reducing transaction costs for inter-regional trade, such a policy may encourage firms to exploit their economies of scale by concentrating production in a single location. For firms whose wage cost is relatively low, this will mean concentrating production in the wealthy region, even if it means exporting part of that production to the poor region at low cost, thanks to the new transport

37 Blömstrom, Lipsey and Zejan (1993) and Barro (1997)
38 The same happens in a monetary integration with respect to transaction costs.

Figure 5.11 *Growth rate versus transport infrastructures.*



infrastructures"[39]. Once production has been moved, with a lower labour demand, it is probable that we could observe effects on migration too and in such cases the final effect of larger infrastructures is, for the regions concerned, less capital and less human resources.

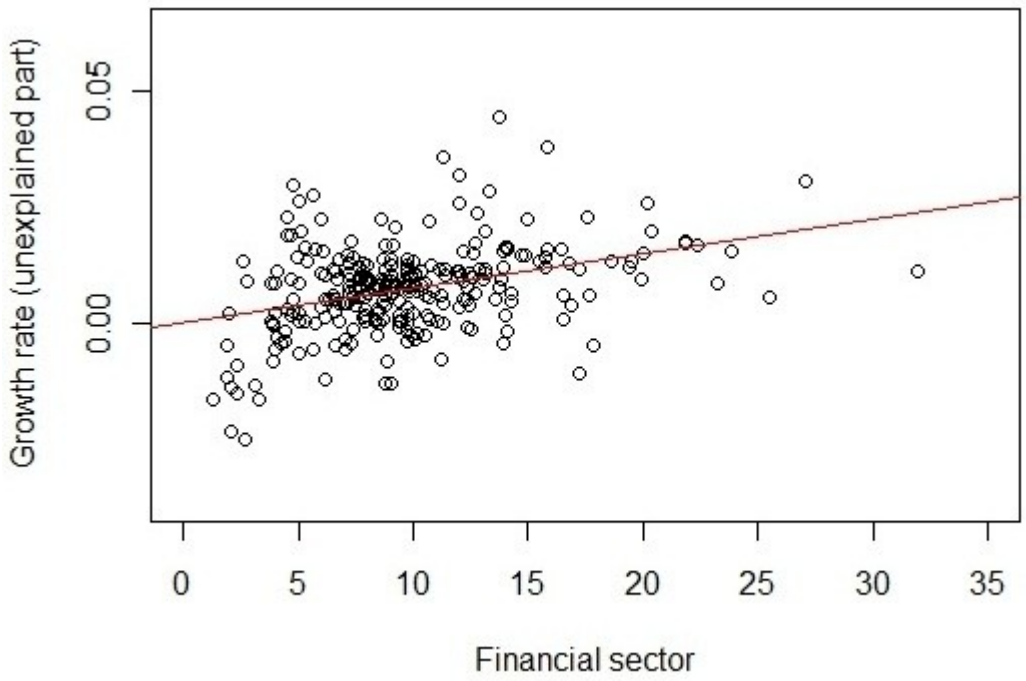
Under another point of view we should also consider again that during the years from 1995 to 2007, strong episodes of growth have been registered in regions which have increased dramatically their construction sector, which were the ones less endowed of infrastructures. As consequence of it we might think that a part of the growth observed could be based in the realization of infrastructures in the regions which had not them.

Anyway to the previous argument should be paid special attention during the decisional process of realization of a transport infrastructure, because too often we hear

39 See Martin and Rogers (1995), and Martin (1999).

the empty equation “infrastructure equals development”, without a deeper consideration of the overall effects to which these may lead.

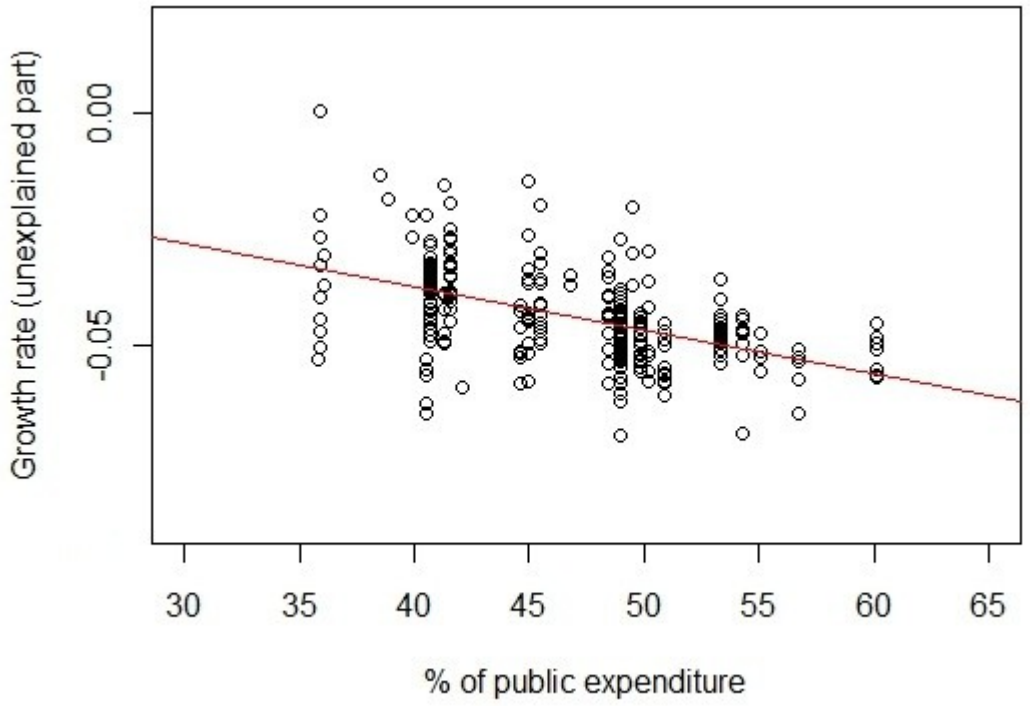
Figure 5.12 *Growth rate versus size of financial sector.*



Financial market

Some analyses have stressed the important role of the domestic financial system to stimulate growth. A developed financial system provide better instruments to support growth as said before. However also with this variable there could be problems of reverse causation, since the process of increasing the size of financial is registered in any experience of growth, but we excluded them by using data of 1995, just at the beginning of the period considered, and the coefficient of the relation shown in figure 5.12 is positive and highly significant. It is worth remarking that the sizes of the other sectors have not had overall significant coefficient in explaining growth, hence we can assign a kind of supremacy to financial sector, even if the regions where it was more development suffered to a larger extent the latest financial crisis. In any way finance can substitute real economy.

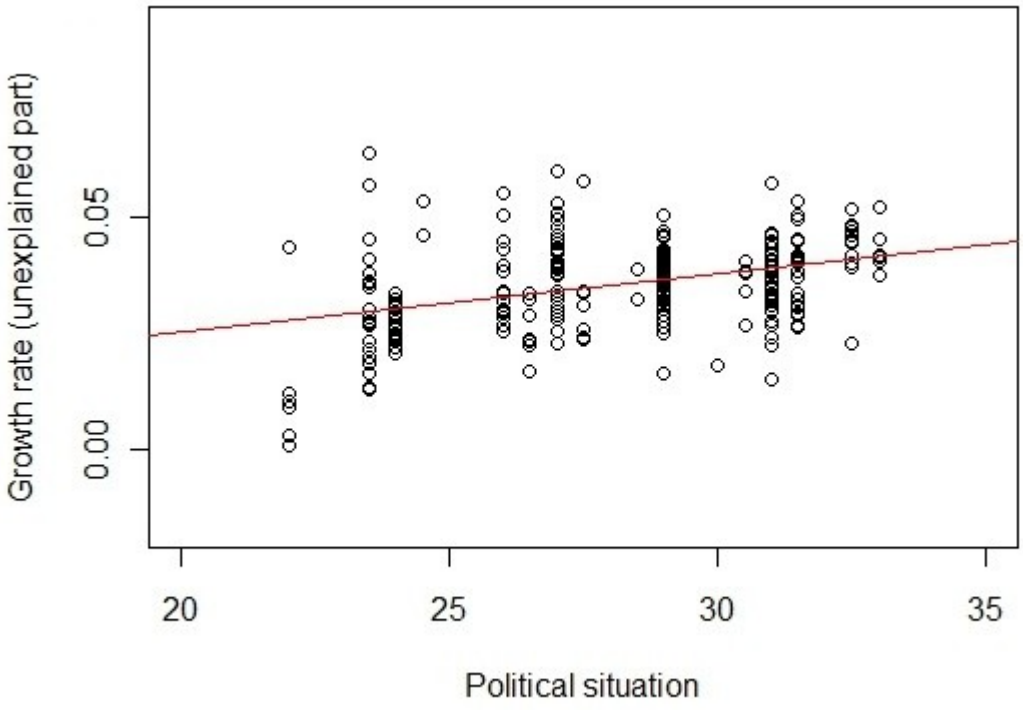
Figure 5.13 *Growth rate versus government consumption.*



Government consumption

One of the most significant coefficient of the regression in table 5.1 is the one relative to the ratio of public expenditure over total GDP. Data are at country level and are intended to be a proxy to measure non-productive spending that furthermore affect economic system through the associated taxation, which, as usual, implies distortions in agents' choices. The estimated coefficient, 0.00093 (0.00017), means that a reduction of one point in the ratio of government consumption contributes to increase growth of almost 0.1%. The partial relation shown in figure 5.13 confirms that big government is bad for growth.

Figure 5.14 *Growth rate versus political situation.*



Political framework

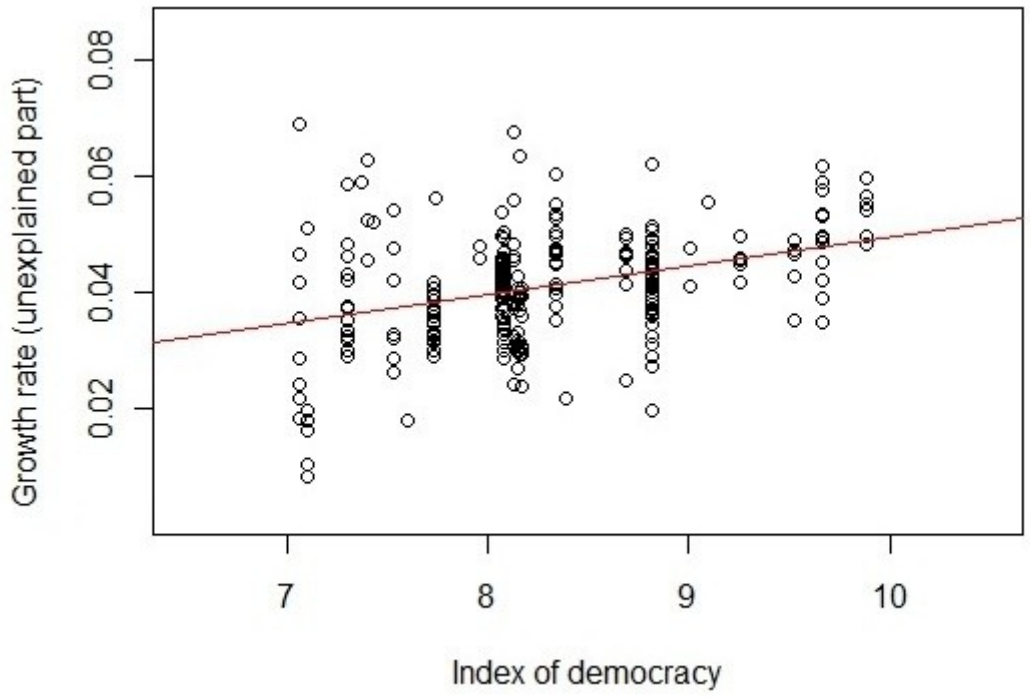
Using this kind of index was first proposed by Knack and Keefer (1995). We have used a reduced version with respect to what Barro calls rule-of-law variable: this is mainly because there are dimensions which are relevant worldwide – for example external conflict, military in politics and religious or ethnic tensions – but that are not sensitive in a European framework. We have specified before the dimensions which form this index: in addition to the waste of resources that internal conflict, corruption or bureaucracy cause, another underlying idea is that a positive political framework can raise the attractiveness of a territory for investment with further obvious repercussions on growth. The index is subjective, but it is prepared by expert for fee-paying international investors and this is in some way a guarantee of its validity and accuracy.

We can observe the partial relation between political framework and growth, which is significantly positive, in figure 5.14. Specifically an improvement of one point in this ranking has the effect to raise growth of more than 0.1%.

Democracy

The democracy variable, another subjective measure, considered at European level has not the same effect which has been registered worldwide by Barro and Sala-i-Martin. According to their studies the relations between it and growth is quadratic and negative when levels of democracy are already satisfactorily high (the overall situation of countries which form EU). The estimated coefficient of our model 0.0049 (0.0018) is positive, hence an improvement in the quality of European democracies has still positive effects on growth. Furthermore, looking at the partial relation shown in figure 5.15, it appears clear that in this case we can exclude the quadratic form.

Figure 5.15 *Growth rate versus democracy index.*

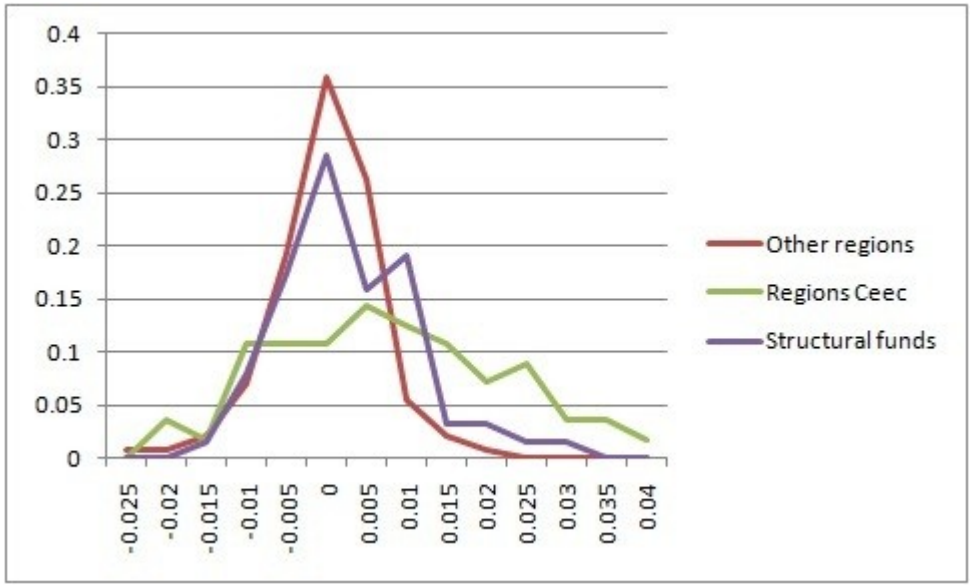


Regional dummies

From the estimated coefficients of regional dummies it appears that growth has been stronger at 5% of significance in the regions pertaining to the counties that joined EU in the last ten years. Here, in the period considered, it was experienced an increase

of income on average of 0.7% than elsewhere. The same cannot be said about the western regions which, during the same years and specifically during the first sub-period, had been receiving structural funds since they had requirements to be part of Objective 1 areas (per capita GDP below 75% EU15 average). The coefficient of their dummy is positive but not significant neither at 10% confidence, hence from this simple result it could be concluded that regional aids had not relevant effect on growth. Of course there are better, deeper and more precise ways to assess what has been the impact of Community funds: literature about this topic is already very enormous and authors often have opposite ideas and conclusions, but this simple method could be sufficient to feed the debate on whether there are better ways, more effective and less distorting to stimulate growth in depressed regions.

Figure 5.16 *Distributions of residual growth for groups of dummy variables.*



In figure 5.16 we can see which are the different distributions of the residual growth for the three groups emerging by using dummy variables (regions pertaining to CEECs, regions financed with structural funds and the others) once we have held constant all the other variables. The regions others than those indicated by dummies present a more concentrated distribution which differs from the distribution of the Objective 1 areas because the latter is slightly more skewed to the right. On the contrary

distribution of CEEC regions is not very concentrated and has a much thicker right tail. Then also from the graph we can conclude that relevant differences in partial growth performances exists between CEECs regions and the EU15 regions and not inside EU15 between Objective 1 areas and the rest.

Other variables

Among other variables that often enter in Barro equations, as inflation rate or openness to trade, the only we have found to be significant is the ratio of crime perpetrated over the regional population, which is easily interpreted as a proxy of security conditions. Negative coefficient supports the idea that regions which are less afflicted by criminality grow more than the others and in this sense a government investment in security might maybe be productive.

5.4 Conclusions

There is a large set of explanatory variables which influence the different per capita regional growth rate in European Union. Conditional convergence is confirmed, even if the process is slow. The estimated coefficients of human and physical capital are consistent with neoclassical theories, whereas we do not register any impact of natural population trend and health conditions. The only demographic variable which is significant is net migration, able to enrich per capita regional GDP, despite it implies an increase of population. Our findings exclude agglomeration effects, but we remark that, generally, environmental conditions are relevant to support growth or not hamper it. Finally, this analysis does not allows to reject the hypothesis that Community structural funds have had no impact on growth of the regions which have received them.

Summary of Results and Conclusions

From the analyses of convergence in per capita GDP among European regions using alternative methods emerge many common results and some finding which is different according to the kind of technique applied.

In general the presence of a slow process of convergence is confirmed, but we have not detected unique findings about its evolution: specifically β-convergence estimated on panel data and inequality measured through Theil Index seem to support the idea that the process occurred mainly in the second sub-period, characterized by the effectiveness of European Monetary Union and by the entry of CEECs; whereas Markovian systems suggest that in the same period it was experienced a slow down of convergence with respect to the previous years.

About β-convergence we remark that, if we consider it in absolute terms, the estimated coefficients are always lower than 2% which is the normal speed registered by the most researches worldwide. This result pushes to think that, even in Europe, convergence is indeed a conditional process and, in fact, models setted for assessing this option have fitted significantly better.

There is a large set of factors which are founded to be able to have significant influence on economic growth. In this field it is worth to note that, both with parametric and non-parametric analyses, educations does not seem to have played an important role in regional development. Especially with the study based on Markovian process it appears that the strong growth experienced by some lagging areas has not solid roots and the crises of the last years, to some extent, has confirmed this suspicion: what often seemed economic miracles were just property bubbles. Nevertheless Barro analysis suggests that there could be an indirect impact of education. Net migration, which has implications both in terms of population and of human resources, is a factor which surely is resulted positive, but we have excluded agglomeration effects even if capitals' regions are the ones that have grown more.

In addition to these factors we should never forget that geographical and

historical dimensions are fundamental for explaining what happens in Europe: Mediterranean regions, which pertain to EU since long time, have not almost changed their relative position, although they had received relevant amounts of aid; Eastern and former communist regions have improved a lot their situation but they are still far from average levels of income of EU. The clubs of convergence which emerge in the Union follow, hence, a core/periphery pattern which is not very different from the current situation. Under this aspect we can detect the existence of a spatial structure which does not take national borders into consideration.

Moreover, decomposition of total inequality confirms what emerged from other studies: the most of convergence achieved is due to reduction in between-country disparity at the expense of a greater inequality inside the countries.

Finally, we must remark that the scenario is constantly in evolution and it is easy observe great changes just in a few months, hence the importance of this topic at European level will be bound to capture, in the future more than ever, the attention of economists and policy makers.

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Annex

List of Regions

BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest
BE21	Prov. Antwerpen
BE22	Prov. Limburg
BE23	Prov. Oost-Vlaanderen
BE24	Prov. Vlaams-Brabant
BE25	Prov. West-Vlaanderen
BE31	Prov. Brabant Wallon
BE32	Prov. Hainaut
BE33	Prov. Liège
BE34	Prov. Luxembourg
BE35	Prov. Namur
BG31	Severozapaden
BG32	Severen tsentralen
BG33	Severoiztochen
BG34	Yugoiztochen
BG41	Yugozapaden
BG42	Yuzhen tsentralen
CZ01	Praha
CZ02	Střední Cechy
CZ03	Jihozápad
CZ04	Severozápad
CZ05	Severovýchod
CZ06	Jihovýchod
CZ07	Střední Morava
CZ08	Moravskoslezsko
DK01	Hovedstaden
DK02	Sjælland
DK03	Syddanmark
DK04	Midtjylland
DK05	Nordjylland
DE11	Stuttgart
DE12	Karlsruhe
DE13	Freiburg
DE14	Tübingen
DE21	Oberbayern
DE22	Niederbayern
DE23	Oberpfalz
DE24	Oberfranken
DE25	Mittelfranken
DE26	Unterfranken
DE27	Schwaben
DE30	Berlin
DE41	Brandenburg - Nordost
DE42	Brandenburg - Südwest
DE50	Bremen
DE60	Hamburg
DE71	Darmstadt
DE72	Gießen
DE73	Kassel
DE80	Mecklenburg-Vorpommern
DE91	Braunschweig
DE92	Hannover
DE93	Lüneburg
DE94	Weser-Ems
DEA1	Düsseldorf
DEA2	Köln
DEA3	Münster
DEA4	Detmold
DEA5	Arnsberg
DEB1	Koblenz
DEB2	Trier
DEB3	Rheinhessen-Pfalz
DEC0	Saarland
DED1	Chemnitz
DED2	Dresden
DED3	Leipzig
DEE0	Sachsen-Anhalt
DEF0	Schleswig-Holstein
DEG0	Thüringen
EE00	Eesti
IE01	Border, Midland and Western
IE02	Southern and Eastern
GR11	Anatoliki Makedonia, Thraki
GR12	Kentriki Makedonia
GR13	Dytiki Makedonia
GR14	Thessalia
GR21	Ipeiros
GR22	Ionia Nisia
GR23	Dytiki Ellada
GR24	Sterea Ellada
GR25	Peloponnisos

GR30	Attiki
GR41	Voreio Aigaio
GR42	Notio Aigaio
GR43	Kriti
ES11	Galicia
ES12	Principado de Asturias
ES13	Cantabria
ES21	País Vasco
ES22	Comunidad Foral de Navarra
ES23	La Rioja
ES24	Aragón
ES30	Comunidad de Madrid
ES41	Castilla y León
ES42	Castilla-la Mancha
ES43	Extremadura
ES51	Cataluña
ES52	Comunidad Valenciana
ES53	Illes Balears
ES61	Andalucía
ES62	Región de Murcia
ES63	Ciudad Autónoma de Ceuta
ES64	Ciudad Autónoma de Melilla
ES70	Canarias
FR10	Île de France
FR21	Champagne-Ardenne
FR22	Picardie
FR23	Haute-Normandie
FR24	Centre
FR25	Basse-Normandie
FR26	Bourgogne
FR30	Nord - Pas-de-Calais
FR41	Lorraine
FR42	Alsace
FR43	Franche-Comté
FR51	Pays de la Loire
FR52	Bretagne
FR53	Poitou-Charentes
FR61	Aquitaine
FR62	Midi-Pyrénées
FR63	Limousin
FR71	Rhône-Alpes
FR72	Auvergne
FR81	Languedoc-Roussillon
FR82	Provence-Alpes-Côte d'Azur
FR83	Corse
FR91	Guadeloupe
FR92	Martinique
FR93	Guyane
FR94	Réunion
ITC1	Piemonte
ITC2	Valle d'Aosta/Vallée d'Aoste
ITC3	Liguria
ITC4	Lombardia
ITD1	Provincia Autonoma Bolzano/Bozen
ITD2	Provincia Autonoma Trento
ITD3	Veneto
ITD4	Friuli-Venezia Giulia
ITD5	Emilia-Romagna
ITE1	Toscana
ITE2	Umbria
ITE3	Marche
ITE4	Lazio
ITF1	Abruzzo
ITF2	Molise
ITF3	Campania
ITF4	Puglia
ITF5	Basilicata
ITF6	Calabria
ITG1	Sicilia
ITG2	Sardegna
CY00	Kypros/Kibris
LV00	Latvija
LT00	Lietuva
LU00	Luxembourg
HU10	Közép-Magyarország
HU21	Közép-Dunántúl
HU22	Nyugat-Dunántúl
HU23	Dél-Dunántúl
HU31	Észak-Magyarország
HU32	Észak-Alföld
HU33	Dél-Alföld
MT00	Malta
NL11	Groningen
NL12	Friesland
NL13	Drenthe
NL21	Overijssel
NL22	Gelderland
NL23	Flevoland
NL31	Utrecht
NL32	Noord-Holland
NL33	Zuid-Holland

NL34 Zeeland
NL41 Noord-Brabant
NL42 Limburg
AT11 Burgenland
AT12 Niederösterreich
AT13 Wien
AT21 Kärnten
AT22 Steiermark
AT31 Oberösterreich
AT32 Salzburg
AT33 Tirol
AT34 Vorarlberg
PL11 Lódzkie
PL12 Mazowieckie
PL21 Malopolskie
PL22 Slaskie
PL31 Lubelskie
PL32 Podkarpackie
PL33 Swietokrzyskie
PL34 Podlaskie
PL41 Wielkopolskie
PL42 Zachodniopomorskie
PL43 Lubuskie
PL51 Dolnoslaskie
PL52 Opolskie
PL61 Kujawsko-Pomorskie
PL62 Warminsko-Mazurskie
PL63 Pomorskie
PT11 Norte
PT15 Algarve
PT16 Centro
PT17 Lisboa
PT18 Alentejo
PT20 Região Autónoma dos Açores
PT30 Região Autónoma da Madeira
RO11 Nord-Vest
RO12 Centru
RO21 Nord-Est
RO22 Sud-Est
RO31 Sud - Muntenia
RO32 Bucuresti - Ilfov
RO41 Sud-Vest Oltenia
RO42 Vest
SI01 Vzhodna Slovenija
SI02 Zahodna Slovenija
SK01 Bratislavský kraj
SK02 Západné Slovensko
SK03 Stredné Slovensko
SK04 Východné Slovensko
FI13 Itä-Suomi
FI18 Etelä-Suomi
FI19 Länsi-Suomi
FI1A Pohjois-Suomi
FI20 Åland
SE11 Stockholm
SE12 Östra Mellansverige
SE21 Småland med öarna
SE22 Sydsverige
SE23 Västsverige
SE31 Norra Mellansverige
SE32 Mellersta Norrland
SE33 Övre Norrland
UKC1 Tees Valley and Durham
UKC2 Northumberland and Tyne and Wear
UKD1 Cumbria
UKD2 Cheshire
UKD3 Greater Manchester
UKD4 Lancashire
UKD5 Merseyside
UKE1 East Yorkshire and Northern Lincolnshire
UKE2 North Yorkshire
UKE3 South Yorkshire
UKE4 West Yorkshire
UKF1 Derbyshire and Nottinghamshire
UKF2 Leicestershire, Rutland and Northamptonshire
UKF3 Lincolnshire
UKG1 Herefordshire, Worcestershire and Warwickshire
UKG2 Shropshire and Staffordshire
UKG3 West Midlands
UKH1 East Anglia
UKH2 Bedfordshire and Hertfordshire
UKH3 Essex
UKI1 Inner London
UKI2 Outer London
UKJ1 Berkshire, Buckinghamshire and Oxfordshire
UKJ2 Surrey, East and West Sussex
UKJ3 Hampshire and Isle of Wight

UKJ4	Kent
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area
UKK2	Dorset and Somerset
UKK3	Cornwall and Isles of Scilly
UKK4	Devon
UKL1	West Wales and The Valleys
UKL2	East Wales
UKM2	Eastern Scotland
UKM3	South Western Scotland
UKM5	North Eastern Scotland
UKM6	Highlands and Islands
UKN0	Northern Ireland